

# The innermost globular clusters of M87<sup>\*</sup>

M. Montes<sup>1,2†</sup>, J. A. Acosta-Pulido<sup>1,2</sup>, M. A. Prieto<sup>1,2</sup>, J. A. Fernández-Ontiveros<sup>3</sup>

<sup>1</sup> *Instituto de Astrofísica de Canarias (IAC), Vía Láctea s/n, La Laguna, E-38200, Spain*

<sup>2</sup> *Departamento de Astrofísica, Facultad de Física, Universidad de La Laguna, Astrofísico Fco. Sánchez s/n, La Laguna, E-38207, Spain*

<sup>3</sup> *Max-Planck-Institut für Radioastronomie (MPIfR), Bonn, D-53121, Germany*

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## ABSTRACT

We present a comprehensive multiwavelength photometric analysis of the innermost ( $\sim 3 \times 3$  kpc<sup>2</sup>) 110 globular clusters (GCs) of M87. Their spectral energy distributions (SEDs) were built taking advantage of new ground-based high resolution near-IR imaging aided by adaptive optics at the Very Large Telescope (VLT) combined with *Hubble Space Telescope* (HST) ultraviolet–optical archival data. These GC SEDs are among the best photometrically sampled extragalactic GC SEDs. To compare with our SEDs we constructed equally sampled SEDs of Milky Way GCs. Using both these Milky Way cluster templates and different stellar population models, ages of  $> 10$  Gyr and metallicities of  $[\text{Fe}/\text{H}] \sim -0.6$  dex are consistently inferred for the inner GCs of M87. In addition, the metallicity of these GCs is low ( $\Delta[\text{Fe}/\text{H}] \sim 0.8$  dex) compared to that of their host galaxy. These results agree with the idea that the GC formation in M87 ceased earlier than that of the bulk of the stars of the central part of the galaxy. The ages of the inner GCs of M87 support the idea that these central parts of the galaxy formed first. Our data do not support evidence of recent wet merging.

**Key words:** galaxies: individual: M87 – techniques: high angular resolution – globular clusters: general – galaxies: evolution – galaxies: formation

## 1 INTRODUCTION

Globular clusters (GCs) are among the oldest stellar components in galaxies. Their stellar populations have been widely recognized as holding important clues about the formation of both GCs and their host galaxy. It is believed that GCs formed in episodes of intense star formation, i.e. the major star-forming episodes that shaped galaxies (see Brodie & Strader 2006, and references therein). Therefore, the properties of both systems, especially their metallicities, are correlated (e.g. Brodie & Strader 2006).

Our present understanding of massive galaxy formation suggests a two-step scenario: the central part is the relic of the early stages of formation, and their extended halo results from minor merging (e.g. Trujillo, Ferreras & de La Rosa 2011). In this sense, GC systems may provide constraints for this scenario. For example, the presence of GC formation may help to distinguish between two types of minor

mergers in a galaxy: dry (little or no gas) or wet (with gas). For instance, the recent discovery of young star clusters in the central regions of elliptical galaxies (e.g. NGC 1052, Fernández-Ontiveros et al. 2011) is related to the gas provided by past merger events (e.g. Kaviraj 2010a,b).

In order to obtain accurate estimates of age and metallicity it is crucial to have access to a large wavelength range (ideally including UV, optical and NIR). This is valid even for old ages if other parameters (e.g. metallicity) can be fixed a priori (Anders et al. 2004). Examples of this can be found in a series of papers by Wang et al. (2010, and references therein), where the M31 GCs were derived from model fitting of the spectral energy distributions (SEDs). The NIR is mainly dominated by stars populating the red giant branch, hence by using the optical/NIR combination we have a better chance to break the age–metallicity degeneracy inherent in optical wavelengths (e.g. Kissler-Patig, Brodie & Minniti 2002).

In this paper, we focus on M87, the giant elliptical galaxy near the core of the Virgo cluster, as a representative example of a massive galaxy. The GC system of M87 has been one of the most carefully studied extragalactic systems. Its numerous GCs ( $\sim 14000$ , Tamura et al. 2006) and the proximity of the galaxy ( $D=16.1$  Mpc, Blakeslee et al. 2001) make it a perfect target for understanding the formation of massive galaxies. The colour dis-

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<sup>†</sup> E-mail: mireia.montes.quiles@gmail.com (MM)

tribution of M87 GCs reveals two distinct subpopulations in optical colours (e.g. Peng et al. 2009; Waters et al. 2009) defined as *blue* and *red*. The red clusters are more centrally concentrated than the blue clusters (e.g. Kundu et al. 1999; Harris 2009; Strader et al. 2011). Furthermore, the radial distribution of the red GCs closely matches that of the galaxy light (Forte, Vega & Faifer 2012). However, the difference in colours does not translate into a difference in age (Cohen, Blakeslee & Ryzhov 1998; Jordán et al. 2002), but in a difference in metallicity. Kundu et al. (1999) using *HST* imaging found that the two peaks in  $V - I$  corresponded to  $[\text{Fe}/\text{H}] = -1.41$  dex and  $[\text{Fe}/\text{H}] = -0.23$  dex. This difference in metallicity was confirmed by other studies (e.g. Jordán et al. 2002; Kaviraj et al. 2007). Cohen, Blakeslee & Ryzhov (1998) acquired and analysed spectra of 150 GCs in M87 and estimated the metallicity with spectroscopic indices. They found that the M87 GCs show a large range in metallicity, from metal-poor to super-solar. The metallicity distribution of their sample is marginally bimodal in metallicity and has an extended metal-rich tail. Their mean  $[\text{Fe}/\text{H}]$  is  $-0.95$  dex.

Some studies use the capabilities of the *Hubble Space Telescope* (*HST*) to obtain high spatial resolution data of the clusters in other wavelength ranges. Sohn et al. (2006) used STIS imaging of four fields in the inner regions of M87 to obtain near and far-ultraviolet (FUV) photometry finding enhanced UV fluxes in M87 GCs. This UV excess is thought to be caused by the presence of the so-called extreme horizontal branch (EHB), populated by low-mass, helium-burning stars (see O’Connell 1999, for a review). Kaviraj et al. (2007) compiled photometry of M87 GCs spanning the widest wavelength range to date, from the UV to the *I*-band. Their derived ages were significantly in excess of the currently accepted age of the Universe due to this UV excess. Separately, there have been studies in the near-infrared (NIR) range investigating the properties of this GC system (e.g. Kundu & Zepf 2007; Chies-Santos et al. 2011a,b).

This paper presents the first multiband analysis of the GCs in the inner regions of M87 that also includes the NIR range. Advances in IR imaging, improved with adaptive optics, allow us to measure the GCs in the central parsecs of galaxies despite the intense background light of the galaxy. In this paper, we will explore the ages and metallicities of these GCs. This may provide a valuable tool for understanding the early phases of the formation and the consequent evolution of both GCs and their host galaxy.

The structure of this paper is as follows. In Section 2, we present the multiwavelength data used here. Section 3 gives details on the photometry and the SEDs. We explore the age and metallicity distributions of the GCs of M87 in Section 4 with an improved accuracy due to the inclusion of NIR quality imaging. In Section 5, we compare our results with previous studies and interpret them in the context of galaxy formation.

## 2 DATA

### 2.1 NIR Data

The NIR data used here consist of high spatial resolution images in the *J* and *K<sub>s</sub>* bands acquired with the Very

Large Telescope (VLT) using the Nasmyth Adaptive Optics System plus the Near-Infrared Imager and Spectrograph (NAOS + CONICA, NaCo). The inner  $\sim 38 \times 38$  arcsec<sup>2</sup> ( $\sim 3 \times 3$  kpc<sup>2</sup>, 1 arcsec = 78 pc at the distance of M87, Blakeslee et al. 2001) of M87 were observed. Two images in the *K<sub>s</sub>* band were taken in 2005 and 2006 targeting a field of view of  $\sim 22 \times 22$  and  $\sim 33 \times 38$  arcsec<sup>2</sup>, respectively. The achieved resolution was  $0''.27$  (*J*) and  $0''.12$  and  $0''.19$  (*K<sub>s</sub>* 2005 and *K<sub>s</sub>* 2006) measured as the full width at half maximum (FWHM) of the most compact source in each image. The NaCo data reduction was performed using the ECLIPSE package provided by ESO (Devillard 1997). Photometric calibration of the images made use of standard stars taken along with the science frames. More details of the data can be found in Table 1. We used the *K<sub>s</sub>* 2005 image for the central part (marked as a red square in the left upper panel of Figure 1), and *K<sub>s</sub>* 2006 for the outer parts.

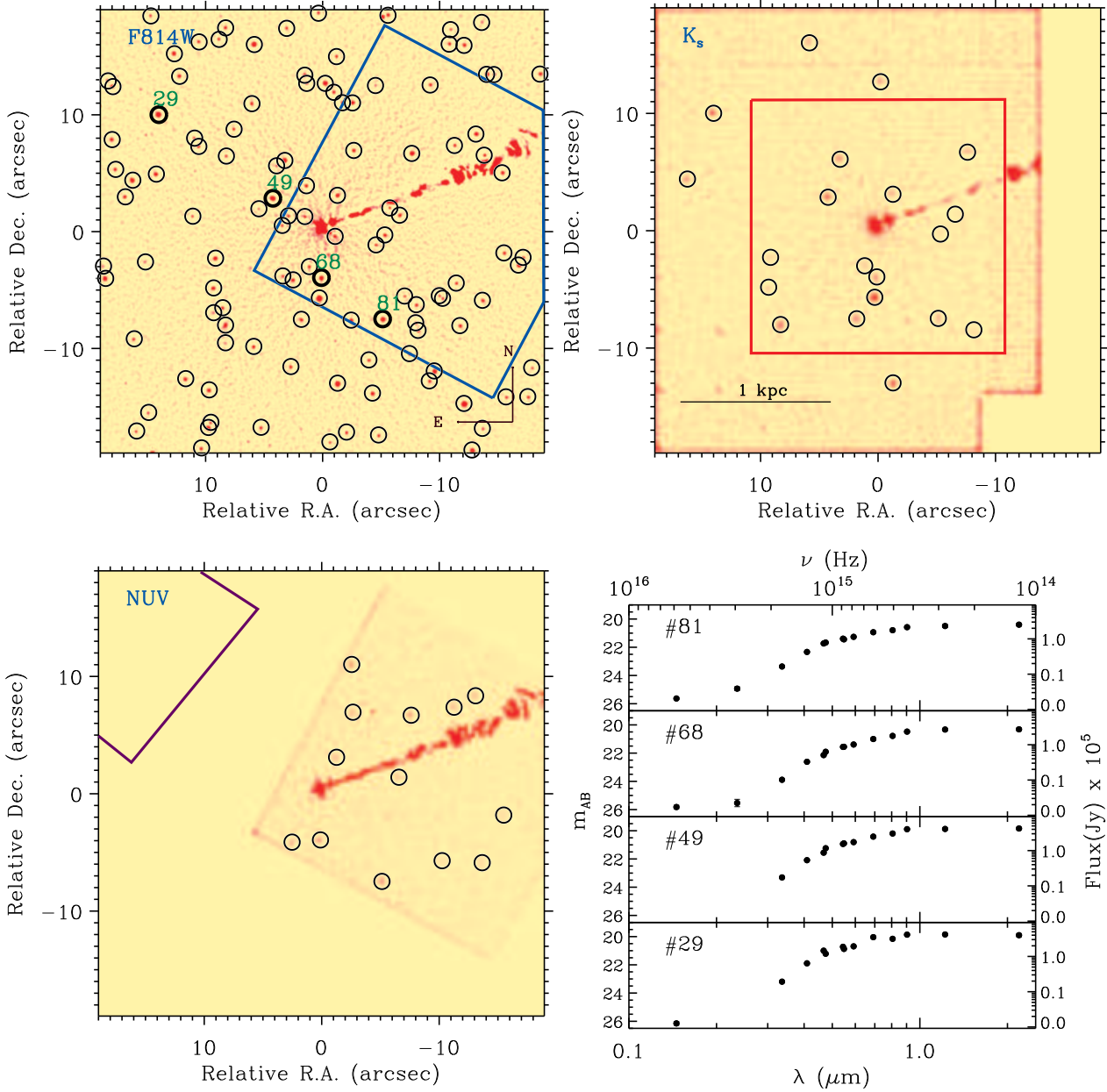
### 2.2 Optical and UV Data

In order to explore the inner regions of M87 with data of comparable resolution, the NIR data were supplemented with *HST* archival data covering the UV–optical range. The optical images are from the WFPC2 and the ACS.

The images from the WFPC2 were taken to observe the jet and the active nucleus with the PC camera, so most of our sources fall within this chip. STIS FUV MAMA (F25SFR2) and NUV MAMA (F25QTZ) images of the central region of M87 were also taken from the archive although they only overlap with half of the NaCo *J*-band field of view (see Figure 1). We also added the F25SFR2 for an adjacent field that covers partially our field of view. The *HST* images were combined using MULTIDRIZZLE (Fruchter & Hook 2002) to achieve the nominal resolution of each camera. MULTIDRIZZLE combines the aligned individual exposures, rejects outliers and removes the geometric distortions. More details about the dataset are listed in Table 1.

## 3 PHOTOMETRY

Image alignment of the whole data set is based on the identification of three sources present in all the filters. We used the deepest image, ACS/F814W, matching the field of view of the NaCo *J* image, for source detection. To enhance the contrast, the unsharp-masking method (Sofue 1993) was used, as illustrated in Figure 1. A median box filter of size  $\sim 2 \times \text{FWHM}$  of the sources was applied to all images and then the filtered images were subtracted from the original ones to remove the diffuse galaxy light. The lists of detected sources in each image were cross-correlated to create the final catalogue. Table C1 lists the right ascension and declination of the sources relative to the nucleus of M87, and their correspondence with Kundu et al. (1999) optical and Sohn et al. (2006) UV data. Detection and photometry of the sources were carried out using SEXTRACTOR (Bertin & Arnouts 1996) on the original images. The detection algorithm recovered a total of 129 sources in the F814W image using a threshold of five connected pixels at a  $3\sigma$  significance level. The photometry was carried out by means of aperture photometry with SEXTRACTOR. In our case, an aperture of the size  $\sim \text{FWHM}$  of the sources was



**Figure 1.** The upper left panel shows the unsharp-masked F814W *HST* image smoothed with a median filter of  $0''.25$  for the central  $38 \times 38 \text{ arcsec}^2$  of M87 corresponding to the  $J$ -band field of view. The detected sources are marked by circles. The upper right and bottom left panels show the corresponding unsharp-masked  $K_s$  and NUV STIS images respectively with the detected sources marked. The blue square in F814W corresponds to the FOV of the NUV image. The red square in  $K_s$  corresponds to the FOV of the  $K_s$  image of 2005 and the purple square in NUV corresponds to the F25SFR2 image of 2002. Bottom right panel: SEDs of a subsample of 4 GCs, marked and numbered in the F814W image.

used ( $\sim 0''.16$  in the optical,  $\sim 0''.13$  in the UV and  $\sim 0''.25$  in the IR).

To determine the completeness and to correct the contamination produced by the strong background light of the galaxy, we run a number of simulations locating artificial GCs on the images. This correction, or bias, is a position-dependent correction that accounts for the galaxy light, as well as for aperture corrections. This is obtained in the completeness tests. Further details on these tests are

provided in Appendix A. For illustration, Table 2 shows the upper limits in magnitude defined as 68 per cent of completeness for three radial distances from the nucleus of M87.

From the initially detected 129 sources in the *HST*/F814W image, only those located in regions with completeness (defined in Appendix A) higher than 68 per cent ( $1\sigma$ ) in the simulations were kept. This leaves us

Filter	$\lambda$ (Å)	$\Delta\lambda$ (Å)	Instrument	Pixel scale (″/pixel)	Exp. Time (s)	Date	Programme
F25SRF2							
FUV-MAMA	1456.6	120.8	STIS@ <i>HST</i>	0.025	3526	17/05/1999	8140
F25SRF2							
FUV-MAMA	1456.6	120.8	STIS@ <i>HST</i>	0.025	2680	14/02/2002	8643
F25QTZ							
NUV-MAMA	2355.3	419.8	STIS@ <i>HST</i>	0.025	2372	17/05/1999	8140
F336W	3359.5	204.5	WFPC2@ <i>HST</i>	0.046/0.1	28800	25/12/2000	8587
F410M	4092.7	93.8	WFPC2@ <i>HST</i>	0.046/0.1	19200	07/02/2001	8587
F467M	4670.2	75.3	WFPC2@ <i>HST</i>	0.046/0.1	7200	28/12/2000	8587
F475W	4745.3	420.1	ACS/WFC@ <i>HST</i>	0.05	750	19/01/2003	9401
F547M	5483.9	205.5	WFPC2@ <i>HST</i>	0.046/0.1	7200	10/02/2001	8587
F555W	5442.9	522.2	WFPC2@ <i>HST</i>	0.046/0.1	2430	03/02/1995	5477
F606W	5919.4	672.3	ACS/WFC@ <i>HST</i>	0.05	28500	24/12/2005	10543
F658N	6590.8	29.4	WFPC2@ <i>HST</i>	0.046/0.1	13900	09/05/1996	6296
F702W	6917.1	586.7	WFPC2@ <i>HST</i>	0.046/0.1	280	23/01/1995	5476
F814W	8059.9	653.0	ACS/WFC@ <i>HST</i>	0.05	72000	24/15/2005	10543
F850LP	9036.4	527.2	ACS/WFC@ <i>HST</i>	0.05	1120	19/01/2003	9401
<i>J</i>	12650.0	2500.0	NACO@VLT	0.027	784	23/01/2006	076.B – 0493(A)
<i>K<sub>s</sub></i>	21800.0	3500.0	NACO@VLT	0.027	300	23/01/2006	076.B – 0493(A)
<i>K<sub>s</sub></i>	21800.0	3500.0	NACO@VLT	0.027	680	20/01/2005	074.B – 0404(A)

**Table 1.** Description of the set of images used in this paper.

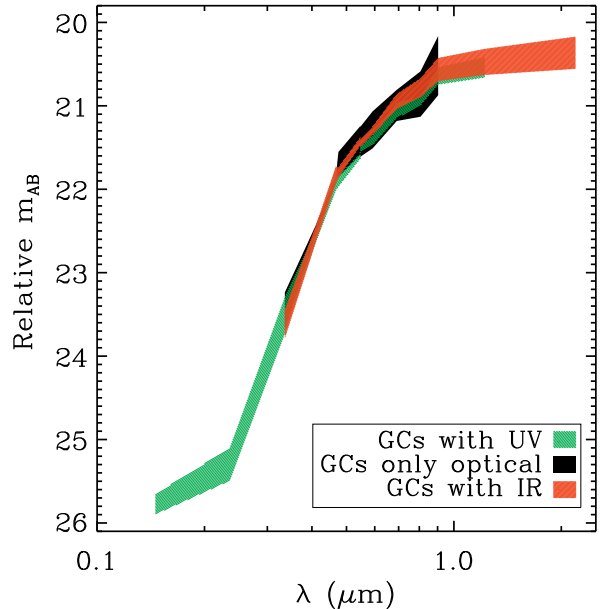
Distance	FUV	NUV	F336W	F410M	F467M	F475W	F555W	
kpc	[mag AB]							
0.5	26.33	26.12	24.63	23.45	23.13	24.05	24.01	
1	26.37	26.21	24.92	23.61	23.19	24.15	24.28	
1.5	26.39	26.87	25.08	24.36	23.47	24.20	24.38	
	F547M	F606W	F658N	F702W	F814W	F850LP	$J$	$K_s$
	[mag AB]							
0.5	24.01	24.35	21.92	22.97	23.48	21.95	21.38	20.76
1	24.29	24.78	21.93	23.17	23.60	22.24	21.40	21.04
1.5	24.53	24.92	21.94	23.53	23.80	22.29	21.44	21.04

**Table 2.** 68 per cent completeness magnitudes for the 15 filters for three radial distances to the centre of M87.  $m - M = 31.03$ 

with a total of 115 sources. For each of these sources, we built a spectral energy distribution from the UV to the NIR. Photometric values in the SEDs were measured in the images after correcting for foreground extinction,  $E(B - V) = 0.022$  (Schlegel, Finkbeiner & Davis 1998), using the Cardelli, Clayton & Mathis (1989) extinction law. Four examples of these SEDs are shown in the bottom right panel of Figure 1. The data for the 115 sources are presented in Table C2 containing the photometry of the 15 filters from the FUV to the NIR in AB magnitudes, together with the errors. There are five objects that are probably not GCs (as explained in Appendix C) and have also been removed from the analysis. The final sample contains 110 objects. The photometry listed in Table C2 includes the additional correction by the bias derived in our simulations while Table C3 does not include this correction.

### 3.1 Spectral Energy Distributions of M87 GCs

Not all our GCs are fully covered photometrically from the UV to the IR. This raises some questions about whether our inferences can be generalized in those cases where we do not have a complete photometric coverage. For this reason, we have built three representative average SEDs of M87 GCs. The averages were defined as three separate groups: *i*) clusters with only optical data (16 clusters), *ii*) clusters with IR

**Figure 2.** Average SEDs for the three groups defined within the GCs of M87 with those emitting in the UV (green), in the IR (orange) and in the optical (black).



and optical data (17 sources, but eight with  $K_s$ ), and *iii*) clusters with UV and optical data (11 sources, only three with NUV and FUV). For each group, an average SED is created by normalizing individual SEDs using the total luminosity integrated upon the common optical bands. In order to avoid biases due to the different exposure times of the bands, we decided to exclude the clusters that do not have information in all of the filters considered.

In Figure 2, we show the three average distributions. The shaded regions represent values between the first and third quartiles. The narrowness of these regions illustrates the similarity of the SEDs of the clusters independently of their photometric coverage. Furthermore, the averaged SEDs show a similar shape, suggesting that the mean properties of the clusters do not differ noticeably. Therefore, we created a unique template SED, ranging from the UV to the NIR, for the clusters of M87 combining the distributions of Figure 2. The final template SED for M87 GCs is shown in Figure 3.

## 4 AGE AND METALLICITY DETERMINATION

### 4.1 Comparison with Galactic clusters: a qualitative approach to age and metallicity

Taking advantage of the wide wavelength range covered in this work, we compared the average SED with the SEDs of a number of Galactic clusters. Deriving SEDs for objects whose properties can be measured by other methodologies provides a valuable tool for comparison. The chosen clusters are: 47 Tuc, NGC 6528, NGC 4147 and NGC 2419. These Galactic GCs (GGCs) span a wide range of metallicities and inhabit different Galactic environments. The ages and metallicities of these clusters are listed in Table 3. For further details on the photometry and properties of these GGCs see Appendix B.

As shown in Figure 3, 47 Tuc is the cluster that best reproduces the average SED of M87 GCs, except in the UV. The fact that the average M87 GC SED replicates the optical–NIR of 47 Tuc indicates that the mean metallicity of the clusters of M87 is similar to that of this GGC, i.e.  $[\text{Fe}/\text{H}] \sim -0.7$ . However, the difference in the UV bands can be explained by the presence of a UV excess ascribed to a significant fraction of EHB stars in M87 GCs (Sohn et al. 2006), which is unseen in 47 Tuc.

Furthermore, we have compared with the open cluster NGC 6791. This old (8.3 Gyr) massive open cluster with supersolar metallicity ( $[\text{Fe}/\text{H}] = 0.45$ ) has hot sources identified as EHB stars that make it a good comparison regarding the UV-enhanced properties of M87 GCs (see Buzzoni et al. 2012, and references therein). The photometry was taken from table 1 of Buzzoni et al. (2012). The observed disagreement in the UV fluxes between M87 GCs and NGC 6791 (although both clusters possess EHB stars) could be explained by a variety of scenarios, including age difference, a larger relative number of HB stars in M87 GCs, or a lower metal abundance in M87 HB stars.

### 4.2 Empirical metallicity determination based on the $V - I$ colour

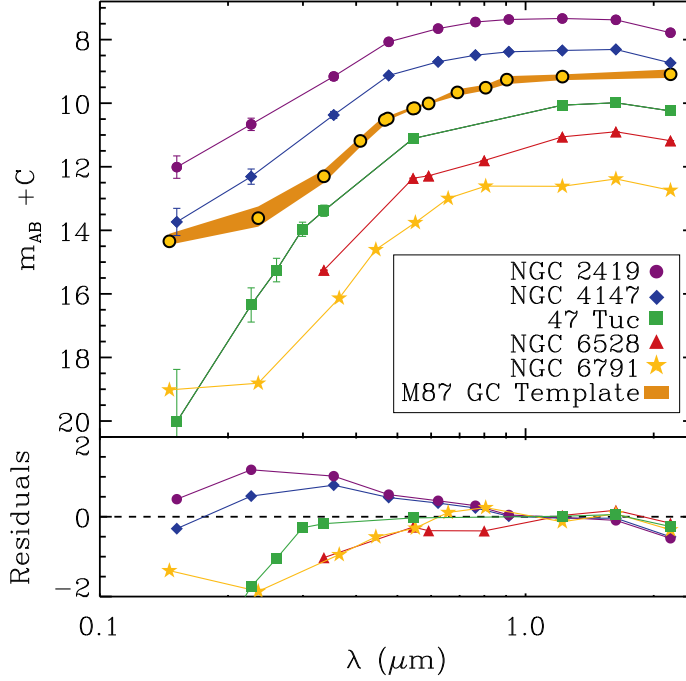
A method of estimating the metallicity of a stellar population, assuming a certain age homogeneity as in the case of M87 GCs (Jordán et al. 2002), is to calculate its optical colours. We derived the  $V - I$  (Vega system) colour of the GCs in the following way. The transformation from the F606W and F814W filter ST magnitudes to Vega magnitudes was taken from Table 10 of Sirianni et al. (2005) and then to the standard  $V$  and  $I$  filters using equation 3 from DeGraaff et al. (2007). Figure 4 shows the colour–magnitude diagram and the histogram of the  $V - I$  colour for our 110 GCs. Different symbols are used to represent clusters belonging to the three groups defined in Section 3.1, depending on the photometric coverage. The mean colour of our sample is  $V - I = 1.1$  mag in agreement with the mean colour in Kundu et al. (1999), Kundu & Zepf (2007) and Peng et al. (2009). To test if this colour distribution can be described by a single-peaked distribution, we calculated the probability that this hypothesis is true using a chi-squared distribution. The single-peaked hypothesis cannot be rejected with a confidence larger than 80%. In Fig. 4, we also draw the median errors in different bins of magnitudes to show that the distribution in  $V - I$  and its scatter is compatible with a single colour (metallicity).

We also included the colour–metallicity transformation derived by Sohn et al. (2006) (their appendix B). They derived a linear relationship between the  $V - I$  colour and  $[\text{Fe}/\text{H}]$ , including information from Galactic GCs and two elliptical galaxies (NGC1399 and M87). The dashed vertical lines specify the interval where this relationship is valid. Contrary to other studies, we find no obvious bimodality in our data. A likely explanation is that our study is restricted to the innermost regions of M87, where the red subpopulation is more concentrated (Strader et al. 2011) and the blue population is not prominent enough. The median of our distribution is  $V - I = 1.1$  mag ( $[\text{Fe}/\text{H}] = -0.75 \pm 0.70$ ), compatible with the mean colour of the GCs in Kundu et al. (1999) ( $V - I = 1.09$ ). This metallicity agrees with the results obtained from the qualitative comparison with GGCs in Section 4.1.

Peng et al. (2006) found that a non-linear relationship better describes the colour–metallicity relationship of globular clusters. Using their non-linear relationship (for 42 clusters with F475W–F850LP colours), we derived a median metallicity of  $[\text{Fe}/\text{H}] = -0.61 \pm 0.40$ , which is compatible with our previous estimate to within  $2\sigma$ .

### 4.3 Absence of recent star formation

Motivated by the discovery of very young stellar clusters in the core region of the elliptical galaxy NGC 1052 (Fernández-Ontiveros et al. 2011), and also taking into account the UV enhancement of the GCs in M87, we searched for  $\text{H}\alpha$  emission associated with these sources. Using a WFPC2 F658N image we measured the  $\text{H}\alpha$  equivalent width (EW) of our clusters. The continuum level was inferred from a linear interpolation between F606W and F702W in magnitude. In those cases where the F702W photometry was not available we used only the F606W flux. All the globulars show an EW in  $\text{H}\alpha$  compatible with zero within errors.



**Figure 3.** Upper panel: Comparison of the average SED for M87 GCs with some MW clusters. The metallicities ( $[\text{Fe}/\text{H}]$ ) for the MW GCs are:  $-2.14$  for NGC 2419 (purple),  $-1.80$  for NGC 4147 (blue),  $-0.70$  for 47 Tuc (green),  $-0.10$  for NGC 6528 (red) and  $+0.45$  for NGC 6791 (yellow). The solid orange polygon corresponds to the average template SED for M87 GCs. Bottom panel: Residuals of the difference between the average of M87 GCs and the MW clusters. The mean metallicity for M87 GCs is  $Z \sim 0.004$  ( $[\text{Fe}/\text{H}] \sim -0.7$ , derived in Section 4.2)

In fact, although there are pieces of evidence for a merger event towards the centre of M87 (e.g. Romanowsky et al. 2012), Pogge et al. (2000) found little presence of nuclear dust which may suggest that no episodes of recent star formation have taken place. This suggests that the merger was probably dry.

#### 4.4 Age and metallicity model dependent estimations

In the following section, we compare the SEDs of M87 GCs with single stellar populations (SSPs) to describe the properties of the clusters in a more quantitative way. The same methodology is used in Montes et al. (2014).

##### 4.4.1 Methodology

In this section, the observed SEDs are compared with that of SSP models to obtain the properties of the stellar populations of the GCs, i.e. metallicity and age. Since our data are integrated luminosities, we convolved the theoretical SED spectra with the transmission curves of the photometric filters to retrieve synthetic photometry for comparison. The computed magnitude, in the AB system, for the  $i^{\text{th}}$  filter is

$$m_{AB}^i = -2.5 \log \frac{\int_{\nu} F_{\nu} \phi^i(\nu) d\nu}{\int_{\nu} \phi^i(\nu) d\nu} + 8.906, \quad (1)$$

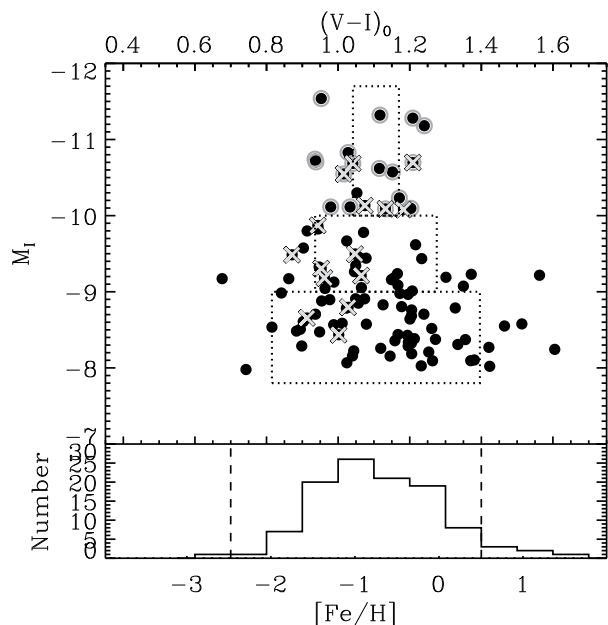
where  $F_{\nu}$  is the theoretical SSP SED expressed in Jy, which is a function of metallicity, age and luminosity, and  $\phi^i$  is the

response curve of the  $i^{\text{th}}$  filter. In order to find the most suitable SSP model, a reduced- $\chi^2$  minimization approach is applied.

$$\chi^2 = \frac{1}{N - n - 1} \sum_{i=1}^N \frac{(m_{obs,i} - m_{mod,i})^2}{\sigma_i^2}, \quad (2)$$

where  $m_{mod,i}$  depend on age, metallicity and luminosity,  $N$  is the number of photometric filters,  $n$  is the number of fitted parameters and  $\sigma_i$  are the observational errors in the photometry of each band. In our case,  $m_{mod,i}$  are the bias-corrected magnitudes while  $\sigma_i$  are the errors derived from the simulations. As there are three parameters for the minimization (age, metallicity and luminosity), there will be at least five spectral bands required for the fit. The models used in this work are the Charlot & Bruzual (2007, hereafter CB) models. The CB SSP models contain 221 spectra describing the spectral evolution of SSPs from 0.1 Myr to 20 Gyr for 6 different metallicities:  $Z=0.0001$ ,  $0.0004$ ,  $0.004$ ,  $0.008$ ,  $0.02$  ( $Z_{\odot}$ ),  $0.05$ . These models cover a range of wavelengths from  $91 \text{ \AA}$  to  $160 \mu\text{m}$ . As the age-metallicity grid is irregular, the metallicity vector was resampled. The grid was expanded with 200 metallicities linearly interpolated from the original SSPs.

None of the SSP models used here is able simultaneously to fit the optical-NIR data together with the UV fluxes. This disagreement originates from the lack of EHB stars in these models. Consequently, fluxes at wavelengths shorter than  $3000 \text{ \AA}$ , if available, were not used in our fits.



**Figure 4.** Upper panel: colour-magnitude diagram of the 110 M87 GCs. Lower panel: histogram of the  $V - I$  colour of the clusters. The open grey circles are the clusters with IR photometry and the crosses mark the clusters with UV counterparts. The metallicity values indicated in the bottom  $x$ -axis were estimated using the linear transformation from  $V - I$  to metallicity provided by Sohn et al. (2006). The dotted boxes represent magnitude intervals in  $y$  and the error of the median in  $x$ .

#### 4.4.2 Robustness of our results

In order to better assess the obtained results for the GCs of M87, we have first checked the reliability of our methodology. Below, we discuss the tests implemented to validate the ages and metallicities obtained from our SED fitting.

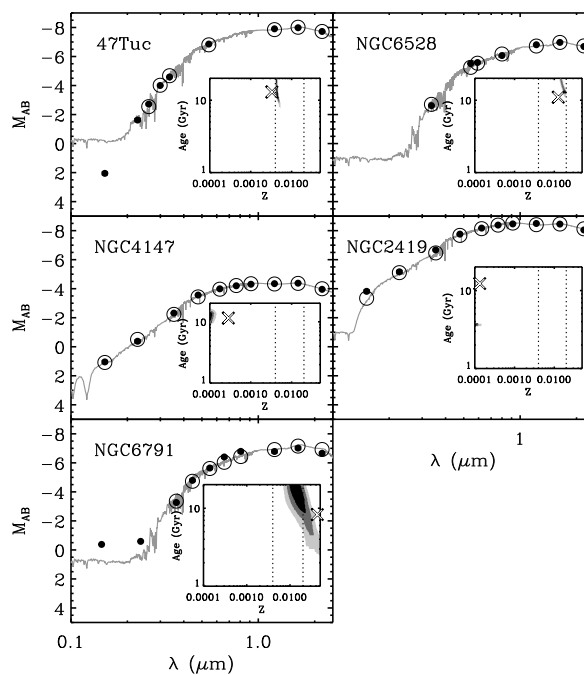
**Test with Galactic Globular Clusters:** Testing our procedure with an observed template of known age and metallicity will enable us to confirm that our methodology accurately retrieves the properties of the clusters. The data of the Galactic globulars encompass the same wavelength sampling as our clusters, but the determinations of age and metallicity have been done using other approaches, such as integrated spectroscopy and isochrone fitting of the main sequence turn-off.

In this case, we convolved with the corresponding transmission curves (see Appendix B for more details on the photometry). In Fig. 5, the best fits for each of the five sample clusters (Figure 1) are shown. The insets show the age and metallicity confidence maps. The errors in age and metallicity are given by the shaded regions that contain the 25, 68 and 95 per cent confidence levels. A comparison between literature values and the best fit is provided in Table 3.

In the case of 47 Tucanae, the UV bands were excluded from the fit since this cluster has a very red HB and radiates weakly in the FUV. It appears as one of the reddest cluster in UV colours in the study of Dorman, O’Connell & Rood

**Table 3.** List of the literature values and best fits using our SED fitting tools found for the GGCs. The errors of the best fits represent the  $1\sigma$  (68 per cent) confidence interval. The detailed information about the “Literature” ages and metallicities of the clusters are given in Appendix B.

	Literature		Best fit	
	Age (Gyr)	[Fe/H]	Age (Gyr)	[Fe/H]
47 Tuc	$13.0 \pm 2.0$	$-0.70 \pm 0.1$	$12.5^{+7.5}_{-3.2}$	$-0.57^{+0.05}_{-0.03}$
NGC 6528	$11.0 \pm 1.0$	$-0.1 \pm 0.2$	$12.8^{+7.2}_{-0.6}$	$0.08^{+0.03}_{-0.03}$
NGC 4147	$11.5 \pm 1.0$	$-1.8 \pm 0.3$	$13.8^{+1.7}_{-4.5}$	$-2.24^{+0.1}_{-0.1}$
NGC 2419	$12.3 \pm 1.0$	$-2.14 \pm 0.15$	$3.8^{+0.3}_{-0.1}$	$-2.24^{+0.1}_{-0.1}$
NGC 6791	$8.3 \pm 0.5$	$0.45 \pm 0.04$	$20.0^{+0.0}_{-4.0}$	$-0.11^{+0.3}_{-0.4}$



**Figure 5.** Best fit models for the GGC SEDs. The filled circles represent the photometry of the clusters. The open circles indicate the convolution of the model with the filter response in each bandpass and the solid grey line is the best fit spectra. The insets show the corresponding age and metallicity maps with the 25 (black), 68 (dark grey) and 95 (light grey) per cent confidence intervals. Crosses indicate the position in the maps of the values of age and metallicity of the clusters found in the literature. The dotted vertical lines indicate the range where STELIB models are reliable.

(1995). Nonetheless, we find a very good agreement with the age and metallicity for this GC. Regarding NGC 6528, the best fit for this cluster recovers its age and metallicity accurately despite the lack of UV data due to constraints in GALEX detectors caused by the proximity of the cluster to the Galactic centre. For NGC 4147, a difference between the literature and the recovered metallicity is found. The fit of NGC 2419 yields an intermediate age for this cluster. The disagreement between the derived ages and metallicities of the latter clusters is probably caused by a bias towards solar metallicity due to the limitations of the stellar library of the CB models, STELIB. The STELIB library contains

mostly stars in the  $0.2 Z_{\odot} < Z < Z_{\odot}$  range (see fig. 2 in Vazdekis et al. 2010, higher than the expected metallicity for NGC 4147). Therefore, the fit to these models tend to produce lower metallicities and/or young ages to compensate for this effect. Apart from the disagreement due to the models, the result for NGC 2419 could also arise due to the presence of a significant ( $\sim 30$  per cent) second generation of stars with extreme helium enhancement (di Criscienzo et al. 2011). Perina et al. (2011) showed that, using integrated photometry and/or spectroscopy, old M31 GCs can appear to be intermediate-age clusters due to the presence of hot HB stars. These stars contribute to enhance the UV flux as well as the strength of the Balmer lines mimicking young ages. Not including the UV bands in the fit of this cluster leads to the same result: the recovered age is younger than expected. We also performed the fit for the open cluster NGC 6791. This cluster is known to host a significant population of EHB stars, consequently we excluded its UV data from the fit. Note that this fit does not reproduce the photometry in the  $R$  and  $I$  bands. We can see that our SSP fits recover quite well the age and metallicity of the GCs in the range of metallicities compatible with our clusters.

**Degeneracy due to photometric errors:** Large photometric errors increase the uncertainty in the determination of ages and metallicities. To estimate the effects of degeneracy on age and metallicity due to these errors, we have carried out Monte Carlo simulations introducing different errors into SSP models with fixed age and metallicity. Our test consists of 10 000 realizations of each model SED. Different error values were explored and gaussian noise was added to the photometry of the simulated clusters. For simplicity, we used the median metallicity derived in Section 4.2:  $Z=0.004$  ( $[\text{Fe}/\text{H}] = -0.7$ ). Two different ages were explored, 1 and 10 Gyr and errors of 0.05, 0.1 and 0.2 mag were assumed. The age and metallicity distributions for the best fit models were analysed and compared to the actual values of the input models.

As stated above, the age-metallicity degeneracy increases as errors increase. For a 10 Gyr SSP, large errors produce a broad peaked histogram of recovered values. For median errors of 0.1 mag, we recover the input values ( $t > 6$  Gyr and  $0.0026 > Z > 0.0055$  dex) in 94 per cent of cases, whereas for median errors of 0.2 mag this lowers to 75 per cent. In contrast, for a 1 Gyr SSP and the same metallicity as above, the recovered ages are much more constrained around the input value (median = 1.0 Gyr and  $\sigma = 0.4$  Gyr). However, metallicities tend to be richer. Consequently, to limit the possible degeneracy, we will select clusters with median photometric errors less than 0.1 mag. This restriction ensures that we properly recover the ages and metallicities of  $\sim 90$  per cent of the clusters.

**Degeneracy due to limited wavelength range:** The inclusion of UV and IR information is crucial to constrain the age and metallicity of stellar populations. Anders et al. (2004) concluded that a well sampled wavelength range, ideally including the NIR and UV, allows one to obtain reasonable SSP estimates. It was also stated that adding NIR data bands restricts the metallicity range. We tested the effect of

including the IR fluxes. In this case, the photometry of the simulated clusters ranges from F336W to  $K_s$ .

A model with 10 Gyr and metallicity  $Z = 0.004$  becomes younger and more metal-rich when not including the UV. If only the optical is used, and restricting to errors below 0.1 mag, only 47 per cent of the total reproduces ages older than 6 Gyr and metallicities in the range:  $0.0026 > Z > 0.0055$  dex. If the  $J$  band is included then the rate increases to 63 per cent. Finally, if the  $K_s$  band is added the rate increases to 86 per cent. For the 1 Gyr and  $Z = 0.004$  model the results present a growing dispersion around the actual values and do not show any degeneracy due to the limited wavelength sampling. This test proves the importance of including NIR photometry when studying old populations.

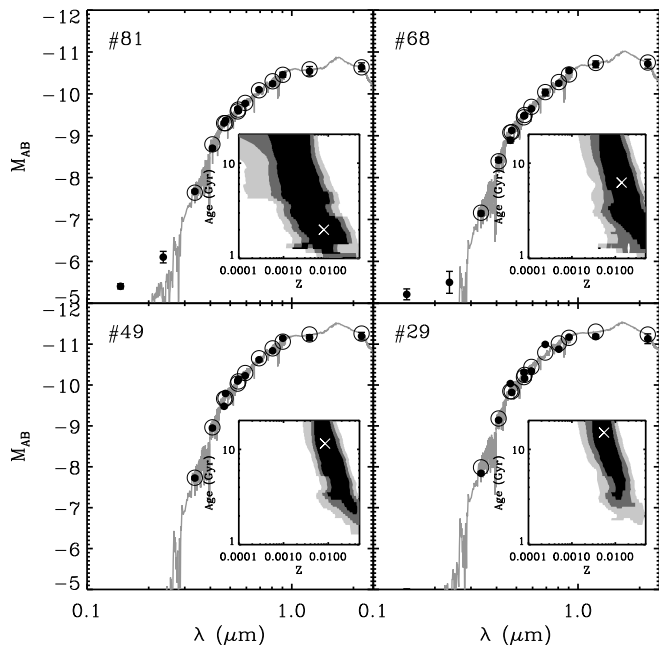
**Model dependency:** It is beyond the scope of this paper to test the different SSP models and investigate the nature of the differences between them. However, in order to provide a qualitative overview of how different synthesis population models fit the SEDs, we compare our results with other SSP models. A new version of the Vazdekis et al. (2010) SSP models contains spectra for 50 ages in the range from 63 Myr to 17.78 Gyr and for seven different metallicities:  $Z=0.0001, 0.0004, 0.001, 0.004, 0.008, 0.019, 0.03$ , spanning from 3464 Å to 9468 Å (Vazdekis et al. 2012, hereafter V12; Ricciardelli et al. 2012). The CB models are based on a Chabrier IMF while the V12 models are based on the nearly identical Kroupa IMF. Unfortunately, V12 models cover only the optical wavelengths, i.e. from F410M to F702W. In order to compare both sets of models consistently we have also estimated the age and metallicity in the optical using the CB models. The comparison was possible for 42 clusters. Ages correlate linearly, although V12 model fits tend to produce an offset towards older ages. The agreement between the two models covers 66 per cent of cases, although there is a bias towards high metallicities due to the limitations of wavelength sampling.

To summarize, IR data and a good signal-to-noise ratio are crucial to minimizing errors and breaking the age-metallicity degeneracy. It is expected that, in the future, models will include blue or extreme HB stars improving the determination of ages and metallicities using SED fits. Note that the bias introduced by the use of the STELIB library probably does not affect the results for our M87 GCs as the STELIB library contains mostly stars in the  $0.004 < Z < 0.02$  range and the mean metallicity of our clusters is  $Z \sim 0.004$ .

#### 4.4.3 Results

As shown in subsection 4.4.2, age and metallicity can be retrieved accurately for  $\sim 90$  per cent of cases when photometric errors are below 0.1 mag and the NIR is present. For this reason, we restrict our analysis to a total of 13 GCs. Figure 6 shows the best fit CB model for four clusters. The open circles represent the expected SEDs for the best fit model, while the black filled circles are the observed SEDs of the clusters. In the insets, the age-metallicity confidence maps are shown, with the black, dark grey and light-grey areas being the 25, 68 and 95 per cent confidence intervals





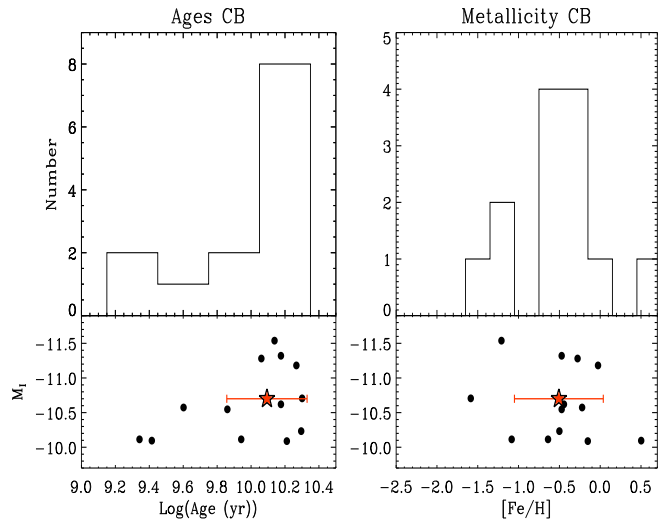
**Figure 6.** SED of four of our clusters (black dots) and best fit CB model (grey line). Open circles represent the convolution of the model with the transmission curves for each filter. The insets show the age–metallicity parameter space and the contours for the 25 (black), 68 (dark grey) and the 95 (light grey) per cent confidence intervals.

respectively. Note that the age–metallicity degeneracy associated with broadband photometry can be appreciated in the confidence maps.

To illustrate our results, Fig. 7 shows the metallicity and age distributions of the best fits versus the absolute magnitude in  $I$  ( $M_I$ , Vega system) for our clusters with IR photometry. In Figure 7, we also indicate the mean age and metallicity and their corresponding uncertainty. The mean parameters are:  $\log(\text{Age}(\text{yr})) = 10.1 \pm 0.2$  and  $[\text{Fe}/\text{H}] = -0.5 \pm 0.5$  dex. The distribution of metallicities seems compatible with the broad but single-peaked distribution derived in Section 4.2, although a more complicated distribution (e.g. double-peaked) cannot be rejected owing to the limited number of clusters. The metallicities derived are in good agreement with those derived independently in Section 4.1 and Section 4.2. Note that for three (20 per cent) of the clusters we retrieve young ages. It is very likely that these young ages are not real but are caused by the age–metallicity degeneracy (two of these clusters lack  $K_s$  band photometry and the errors in the  $K_s$  band are large in the other cluster: 0.20 mag). This fact emphasizes that the  $K_s$  band is crucial for breaking the mentioned degeneracy.

## 5 DISCUSSION

The M87 GC system is one of the most extensively studied GC systems. In our study we have dealt with the innermost GCs, within  $\sim 3 \times 3$  kpc<sup>2</sup>, using a broad wavelength sampling from the UV to the NIR. This is the first multiband



**Figure 7.** Distribution of ages and metallicities for the 13 GCs with NIR photometry. In each panel, the red star corresponds to the mean age and metallicity, respectively.

analysis of these inner M87 clusters that includes the NIR range at subarcsecond resolution. As the centres of elliptical galaxies are the relics of the early stages and the GCs are formed in intense episodes of star formation, these clusters can help us to constrain models of the formation of M87.

In this section, we discuss the properties derived from our analysis compared to the whole population of GCs in M87.

### Is the GC metallicity distribution bimodal?

As mentioned in Section 1, the majority of the studies carried out on extragalactic GCs are limited to the optical range, making colour bimodality one of the most commonly observed properties of the clusters (see Harris 2009, and references therein). In the case of M87, the blue and red clusters show peaks at  $V - I \sim 0.95$  and 1.20, respectively (Kundu et al. 1999; Peng et al. 2009). The mean value of the colour distribution of our GC sample is  $V - I = 1.1$ , which is compatible with the mean colour in Kundu et al. (1999); Kundu & Zepf (2007) and Peng et al. (2009). We found no clear evidence of colour bimodality in our data (see Sec. 4.2). This might be produced by the small number statistics in our sample or, alternatively, by a selection bias: red clusters may be the dominant population in the circumnuclear region of M87 (Harris 2009). Strader et al. (2011) derived the surface density profiles of both subpopulations of GCs and found that red GCs dominate in the inner 2 arcmin. Consequently, most of the GCs in our sample are red GCs.

The physical meaning of this bimodality remains controversial although the most commonly accepted interpretation is that the colour distribution translates into a metallicity bimodal distribution (see Brodie & Strader 2006). However, Chies-Santos et al. (2011a,b) found that the colour bimodality disappears when IR colours ( $g - K$ ) are considered (see their figure 9). Furthermore, Chies-Santos et al. (2012) concluded that a bimodal optical colour distribution does

not necessarily imply a bimodal metallicity distribution, but is a consequence of a non-linear colour-metallicity conversion (see also, Yoon, Yi & Lee 2006; Peng et al. 2006). Metallicities derived photometrically produce  $[\text{Fe}/\text{H}] \simeq -1.5$  dex for the blue clusters and  $[\text{Fe}/\text{H}] \simeq -0.3$  dex for the red clusters (Kundu et al. 1999; Jordán et al. 2002). The metallicities derived by Kaviraj et al. (2007), based on SSP fits from the UV to  $I$ , also agree with these results. In the same direction, Yoon et al. (2011) found that the metallicity distribution function of M87 GCs peaks at  $[\text{Fe}/\text{H}] \simeq -0.5$ . The mean metallicity of our sample of GCs is  $<[\text{Fe}/\text{H}]> \simeq -0.6$  ( $Z \simeq 0.004$ , the mean of the different estimates derived throughout this paper), compatible with the values reported in previous studies. This places our sample in the red (metal-rich) subpopulation, although we also include some blue (metal-poor) GCs. These blue GCs could be also located in the outskirts of M87 but are seen in its central region due to a projection effect.

Based on spectroscopy, Cohen, Blakeslee & Ryzhov (1998) derived ages and metallicities for 150 M87 GCs. They found a marginally bimodal metallicity distribution with a mean metallicity of  $<[\text{Fe}/\text{H}]> = -0.95 \pm 0.5$ . This value is compatible but slightly lower than the results found here using SSP fitting ( $[\text{Fe}/\text{H}] = -0.5 \pm 0.5$ ). This is also caused by the location of their GCs at larger radii (see above, Strader et al. 2011). Unfortunately, all their clusters are beyond our field of view and direct comparison is not possible.

Regarding ages, Kundu et al. (1999), using  $V$  and  $I$  *HST*/WFPC2 colours, found an age difference between the two subpopulations. They estimated an age of 15 Gyr for the blue cluster subpopulation and 9–12 Gyr for the red ones. However, subsequent studies proved them to be equally old to within errors (e.g. Jordán et al. 2002) and the difference in colours can only be explained by a difference in metallicities. Cohen, Blakeslee & Ryzhov (1998) also found that the spectroscopic ages of the 150 GCs are compatible with  $\sim 13$  Gyr. The ages obtained from our SSP model fitting are not well constrained due to the age-metallicity degeneracy, although the resulting ages concentrate around 12 Gyr with no evidence of two subpopulations in age.

Summarizing, according to our results the central GCs of M87 are old and with a mean metallicity of  $[\text{Fe}/\text{H}] \simeq -0.6$  dex, the richest within the population of M87 GCs. We will discuss later on the implications of this for understanding the formation of the innermost region of M87.

#### *GCs vs spheroidal stellar population*

The GCs of M87 seem to be closely linked to the formation history of the galaxy. The ages of the halo stars and the GCs are similar (Kuntschner et al. 2010; Cohen, Blakeslee & Ryzhov 1998). In addition, the spatial distribution of the red subpopulation of M87 GCs in the inner regions of the galaxy, as studied by Kundu et al. (1999) and more recently by Harris (2009), mimics fairly closely the metal-rich spheroid light of the host galaxy (Strader et al. 2011; Forte, Vega & Faifer 2012). Kuntschner et al. (2010) studied M87 spectroscopically using SAURON, and determined that the age of its stellar population is old ( $> 10$  Gyr) and its metallicity is supersolar ( $Z \sim 0.03$ ) in the inner parts of the galaxy ( $R = R_e/8$ , similar to our field of view). The mean metallicity of our GC sample is  $[\text{Fe}/\text{H}] \simeq -0.6$ , which

is about eight times lower than that of the galaxy itself. Similar results were found by Jordán et al. (2004) in a study of four cD galaxies (imaged with the WFPC2), where an offset of  $\Delta[\text{Fe}/\text{H}] \sim 0.8$  dex was found between the GCs and the stellar population of their host galaxies. Consequently, a metallicity offset towards lower metallicities seems a natural outcome if the chemical enrichment process of M87 GCs ceased earlier than that the bulk of stars of the galaxy, as discussed in Yoon et al. (2011).

In this sense, we can sketch the following picture for the formation of M87. Halo stars and GCs were formed in the early phase of the collapse of the gas cloud. Later on, as the gas collapse continued, an intense burst created the nucleus of M87 (see Montes et al. 2014, for a longer discussion). That phase took place around 12 Gyr ago. Subsequent mergers with other galaxies could have brought both metal-poor GCs and the stars of the outer envelope of M87. The fact that no young GCs have been observed in M87 suggests that this merging process was basically dry (see below).

#### *Evidence of a dry merger*

Examples of the dry merging process discussed above could have been detected observationally. In fact, the detection of dust lanes in the circumnuclear region of M87 (Pogge et al. 2000) implies that a merger event took place after the galaxy formation, which does not seem to have induced episodes of formation of GCs, as shown in Section 4.3. The presence of these lanes suggests that the merger occurred  $\lesssim 1$  Gyr ago (Rudick et al. 2009; Romanowsky et al. 2012). Actually, age estimates obtained from comparison with Galactic GC and SSP fitting indicates that the GCs studied are old ( $> 10$  Gyr). However, three of the clusters exhibit rather young ages (1–4 Gyr), probably caused by the methodology applied.

These facts, together with the evidence that a low-luminosity active galactic nucleus is present in M87, suggest that whatever merger activity occurred in the past it was dry. An observation that is consistent with this idea is that the galaxies near the core of galaxy clusters are almost depleted of their gas content (e.g. Chung et al. 2009). Another relevant finding is that of Romanowsky et al. (2012), who show that a substructure in the position-velocity phase space is compatible with the expectations of the recent accretion of a dwarf galaxy into M87.

## 6 SUMMARY AND CONCLUSIONS

We have compiled multiwavelength photometric data for 110 GCs detected in a region of  $\sim 3 \times 3$  kpc<sup>2</sup>. These data are based on high spatial resolution images obtained with VLT/NaCo and instruments on board *HST*. The SEDs for these GCs were built covering a wide wavelength range, from the FUV to  $K_s$ . The use of adaptive optics techniques turns out to be crucial in order to detect and measure GCs close to the nucleus of M87.

The M87 GC SEDs were compared to those of the Milky Way GCs and the mean SED of the M87 GCs is very similar to that of 47 Tuc in the optical-IR passbands but not in the UV range. A similar UV excess (probably due to a hot HB

population) as shown by the M87 GCs was only present in the SED of the open cluster NGC 6791.

Furthermore, ages and metallicities were derived for 13 M87 GCs after fitting SSP models. We performed simulations accounting for the relevance of the different wavelength sampling and photometric errors in the metallicity/age determinations. We conclude that about 90 per cent of the GCs have valid ages and metallicities when photometric errors are below 0.1 mag and the NIR passbands are included. The NIR (especially the  $K_s$  band) has proven to be a useful tool for breaking the degeneracy and thus determining accurate parameters for extragalactic objects.

Most of the metallicities derived for our GCs distribute around the red (metal-rich) peak of the bimodal metallicity distribution, although there is no hint of bimodality in our data. A median value of  $<[\text{Fe}/\text{H}]>\simeq -0.6$  ( $Z\simeq 0.004$ ) was obtained, a result which is in good agreement with previous photometric determinations of the metallicity in the inner regions of M87. The resulting ages are compatible with an old population ( $> 10$  Gyr), which is consistent with previous spectroscopic determinations of the age of GCs in the outer parts of M87. These derived ages are also compatible with the ages of the oldest Galactic GCs. This indicates that no wet merging processes have occurred recently.

The average metallicity derived here for the innermost GC system is lower ( $Z\simeq 0.004$ ) than that of its host galaxy ( $Z\sim 0.03$ ). Taking into account that the spatial distribution of the clusters and that of the field star light are similar, this result suggests that the formation of GCs stopped before the formation of the bulk of stars.

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## APPENDIX A: M87 GCS PHOTOMETRIC ACCURACY

Getting reliable photometry of M87 GCs in the inner regions is not an easy task as the underlying galaxy outshines the light of these systems. This is particularly significant in the redder bands as the galaxy light contribution increases towards the NIR.

To assess the accuracy of our photometry, we performed artificial cluster tests to determine the completeness and errors. To model the simulated clusters, a Moffat function was used. Realistic parameters of the Moffat function were retrieved by fitting this function to isolated GCs on the real images using GALFIT (Peng et al. 2002). The residuals of the fitting to the clusters were less than 20 per cent in all cases.

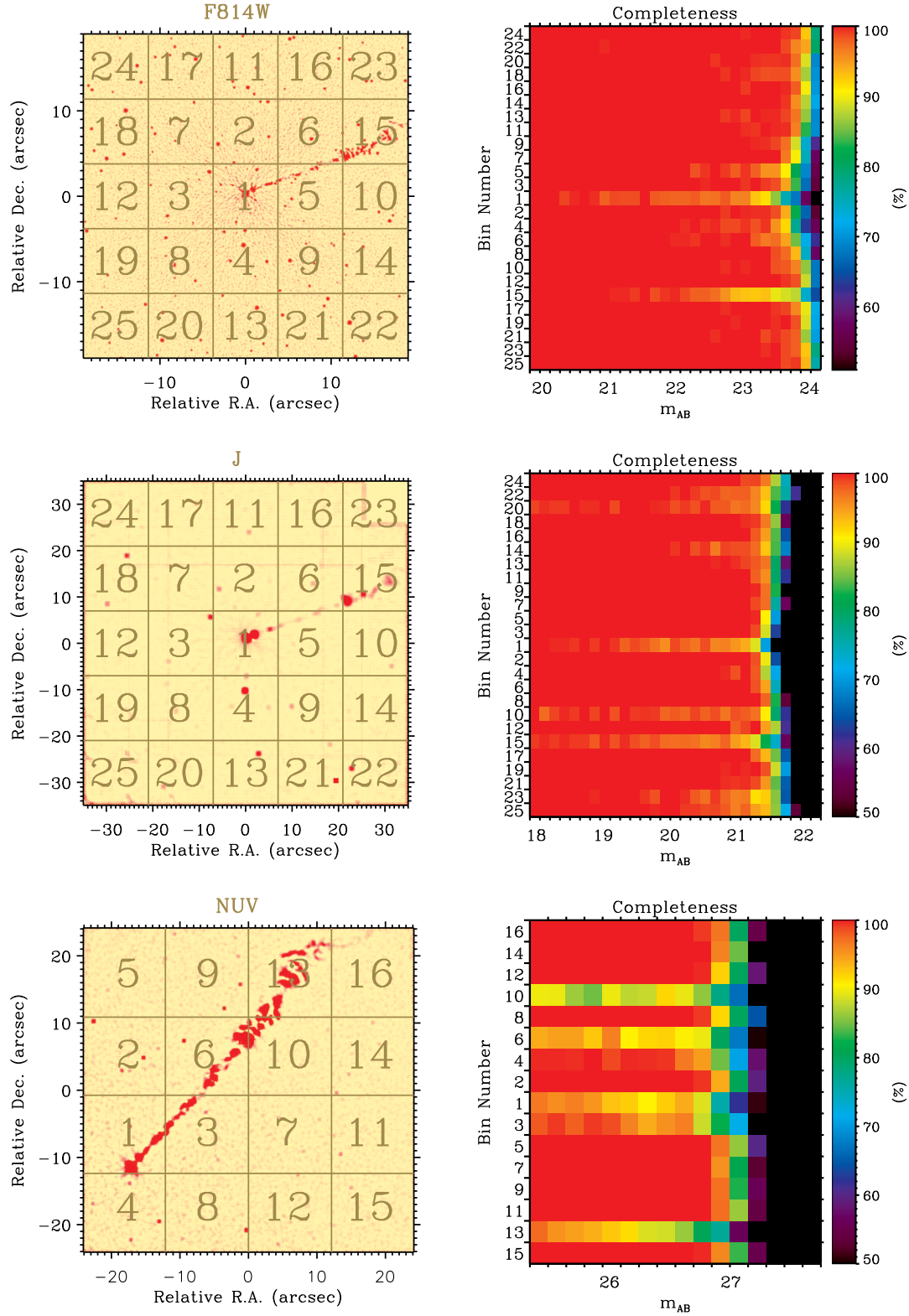
The simulated clusters were randomly distributed across the image. The magnitudes of the simulated clusters expanded the range of the observed GCs. As the influence of the background light of M87 changes through the image, to calculate the parameters of our photometric corrections we have divided the distributions, both spatial and in magnitude, in bins of  $6''.0$  and  $0.15$  mag, respectively. The number of simulated clusters per bin was 250. This gives us good statistics for estimating the corrections. The artificial clusters in all filters thus created were subjected to the same analysis as the real data.

Completeness, bias and errors were derived to account for the reliability of the GC photometry depending on the position of the GCs in the images (i.e. different background contamination as a function of the distance to the centre of the galaxy). The completeness represents the rate of recovered simulated GCs per magnitude and spatial bin. The bias is the median of the difference between the input magnitudes and the recovered magnitudes. Finally, the error is the scatter of the difference between the input and output magnitudes. For a visual description of these parameters, Fig. A2 represents the bias (blue stars) and the error (blue error bars) for a spatial bin.

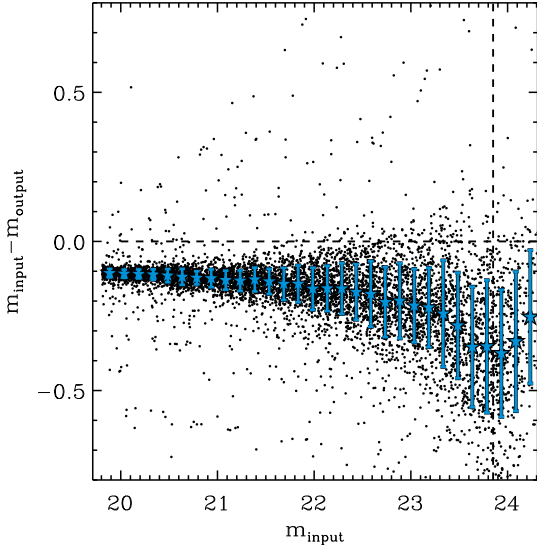
An example of three completeness maps for three filters covering the studied wavelengths in this work can be seen in Figure A1. The bins are numbered, ordered with increasing distance to the galaxy nucleus, shown in the left-most panel. As expected, the detection efficiency depends on the projected radius from the centre of the galaxy. The bias and error increase with decreasing distance, where the background light of the galaxy is more intense and also when the magnitudes of the GCs are fainter. The effect of the presence of the jet in bin #15 is seen.

The completeness tends to be higher in filters with large exposure times, as the ACS/F606W and ACS/F814W and with a low contribution of the background galaxy light, as in the STIS UV bands. The bias is affected by the noise. Shorter exposure images have higher bias. Also, the bias is higher in redder filters as the emission of the diffuse light of the galaxy increases.





**Figure A1.** The three panels represent the completeness derived from the simulations for three different bands; the NUV, the optical (F814W) and the IR (J). The left panels show the division in numbered bins of the image. Note that the NUV has a different image alignment and consequently a different bin configuration.



**Figure A2.** Input magnitude vs Input–Output magnitude for one bin. This figure illustrates the bias and error for a given bin. The bias is the mean of the difference between the input and the recovered clusters in a bin of magnitude (blue stars) The blue error bars are the dispersion of the points around this mean and thus represent our simulated error. The vertical dashed line represents 90 per cent completeness in this spatial bin.

## APPENDIX B: GALACTIC GLOBULAR/OPEN CLUSTERS: DATA

Multiwavelength SEDs of the integrated light of GCs in our Milky Way galaxy do not exist. These SEDs are, however, very important for comparative extragalactic studies where only the broadband colours are accessible. In this paper Milky Way GCs 47 Tucanae, NGC 6528, NGC 4147 and NGC 2419 were selected to construct UV-to-NIR light-integrated SEDs. The selection of clusters was mostly driven by the availability of wide field images over a wide wavelength range. They were also chosen to cover a wide range of metallicities ( $-2.14 < [\text{Fe}/\text{H}] < -0.1$ ). For each cluster, 2MASS, *HST*, SDSS and GALEX images were used. We performed aperture photometry within an aperture radius equal to the core radius of the clusters taken from the Harris catalogue (Harris 1996). The centre of the aperture was set on the centre of the cluster, as defined in Goldsbury et al. (2010) or, alternatively, in the Harris catalogue. In the case of *HST* imaging, short exposure frames were chosen to avoid saturation due to bright stars. The main source of error in the integrated magnitudes is the determination of the photometric zero point, as Poisson noise is too small due to the high photon counts we are integrating. We also added from the literature the open cluster NGC 6791, for its UV properties with respect to its high metallicity such as is not found in any globular cluster in the Milky Way.

### 47 Tucanae

This is the second largest and brightest globular cluster in the sky and for this reason it is one of the most studied old associations of the Milky Way. Its age and metallicity have

been measured both spectroscopically (e.g. Schiavon et al. 2002; McWilliam & Bernstein 2008) and photometrically (i.e. Salaris et al. 2007) and both determinations are in good agreement. The adopted values for the metallicity, age and extinction are:  $[\text{Fe}/\text{H}] = -0.7 \pm 0.1$ ,  $13.0 \pm 2.0$  Gyr and  $E(B - V) = 0.04$ . To build its SED, we used FUV and NUV images from GALEX<sup>1</sup>, F336W, F255W, F300W and F555W from *HST* and *J*, *H* and *K<sub>s</sub>* from 2MASS<sup>2</sup>.

### NGC 6528

This globular cluster is located in Baade’s Window and its relatively low extinction value allows us to use it as a template of an old, metal-rich, bulge globular cluster. Its location near the Galactic centre makes it a natural choice for comparison with our sample of central M87 GCs. The values of metallicity, age and extinction are:  $[\text{Fe}/\text{H}] = -0.1 \pm 0.2$  (Zoccali et al. 2004),  $11.0 \pm 2.0$  Gyr (Feltzing & Johnson 2002) and  $E(B - V) = 0.55$  (Momany et al. 2003). We used the following filters: F336W, F555W, F606W and F814W from *HST* and *J*, *H* and *K<sub>s</sub>* from 2MASS. UV data were not found for this cluster.

### NGC 4147

This cluster is located in the halo of the MW. NGC 4147 is intrinsically rather small and few detailed studies of it are available. It has an age of  $11.5 \pm 1.0$  Gyr (Marín-Franch et al. 2009) and  $[\text{Fe}/\text{H}] = -1.8 \pm 0.3$  (Rutledge, Hesser & Stetson 1997) and  $E(B - V) = 0.026$  from Schlegel, Finkbeiner & Davis (1998). We use FUV and NUV images from GALEX, *u'*, *g'*, *r'*, *i'* and *z'* images from SDSS<sup>3</sup> and *J*, *H* and *K<sub>s</sub>* images from 2MASS.

### NGC 2419

NGC 2419 is a very bright, unusually large GC located at a very large distance from the centre of the Milky Way. It is also one of the most massive MW GCs. It has shown evidence for two subpopulations of stars. It also has a strong EHB (see di Criscienzo et al. 2011). Its properties are:  $[\text{Fe}/\text{H}] = -2.14 \pm 0.15$  (Harris et al. 1997),  $E(B - V) = 0.11$  (Harris 1996) and  $12.3 \pm 1.0$  Gyr (Salaris & Weiss 2002). FUV and NUV are from GALEX, *u'*, *g'*, *r'*, *i'* and *z'* from SDSS and *J*, *H* and *K<sub>s</sub>* from 2MASS.

### NGC 6791

This is an  $8.2 \pm 0.5$  Gyr (Grundahl et al. 2008) massive open cluster with supersolar  $[\text{Fe}/\text{H}] = +0.45 \pm 0.04$  (Anthony-Twarog, Twarog & Mayer 2007) metallicity. It has hot sources identified as EHB stars (see Buzzoni et al. 2012, and references therein). The photometry, from the UV to the NIR, was taken from Buzzoni et al. (2012). As Buzzoni et al. (2012) do not include errors for their photometry we assumed a relative error of 2 per cent.

<sup>1</sup> Galaxy Evolution Explorer, see <http://www.galex.caltech.edu/>

<sup>2</sup> Two-Micron All-Sky Survey, see <http://www.ipac.caltech.edu/2mass/>

<sup>3</sup> Sloan Digital Sky Survey, see <http://www.sdss.org/>

In Figure 3 the SEDs for the galactic clusters are shown. The photometric data can be found in Table B1.

47 Tuc	FUV	NUV	F255W	F300W	F336W	F555W	J	H	K	
	15.4 ±1.6	11.7 ±0.5	10.6 ±0.4	9.4 ±0.2	8.8 ±0.2	6.51 ±0.07	5.46 ±0.04	5.39 ±0.04	5.64 ±0.05	
NGC 6528	F336W		F555W	F606W	F814W	J	H	K		
	13.5 ±0.3		10.6 ±0.1	10.5 ±0.1	10.1 ±0.1	9.3 ±0.1	9.2 ±0.1	9.5 ±0.1		
NGC 4147	FUV	NUV	u	g	r	i	z	J	H	K
	17.5 ±0.4	16.1 ±0.2	14.1 ±0.1	12.92 ±0.06	12.49 ±0.05	12.28 ±0.04	12.18 ±0.04	12.14 ±0.04	12.10 ±0.04	12.53 ±0.06
NGC 2419	FUV	NUV	u	g	r	i	z	J	H	K
	16.0 ±0.3	14.6 ±0.1	13.1 ±0.1	12.07 ±0.08	11.65 ±0.07	11.44 ±0.06	11.36 ±0.06	11.33 ±0.06	11.37 ±0.07	11.78 ±0.08
NGC6791	FUV	NUV	U	B	V	R	I	J	H	K
	13.07	12.86	10.18	8.65	7.80	7.04	6.66	6.67	6.43	6.79

**Table B1.** Data for the MW Globular/Open Clusters.



## APPENDIX C: DATA FOR M87 GLOBULAR CLUSTERS

The multiwavelength photometric data for the 115 M87 GCs are presented in Tables C1, C2 and C3. Table C1 presents the number of the clusters and their distance to the centre. Tables C2 and C3 contain the number assigned to the cluster in this work (first column), the radial distance relative to the centre (second column) and the magnitudes in the AB system for the 15 filters used (column 2-15) with their errors. The photometry is corrected for Galactic reddening and bias and the errors correspond to the errors derived in Sec. A in C2. In Table C3, we did not correct the photometry bias or extinction, but the errors are from the simulations.

The objects removed from the analysis are: #54 and #58 (faint sources near the active nucleus and probably contaminated by it), #74 (a compact and extremely red object in  $V - I$ , possibly a star), #82 and #85 (diffuse and red in  $V - I$ , probably background galaxies). The asterisks mark those objects whose magnitudes are fainter than 68 per cent completeness in the simulations. Table 2 shows the upper limits in magnitude for three radial distances from the nucleus of M87. The 13 clusters used in Section 4.4.3 are marked with a cross.

Table C1: Coordinates of the detected 115 sources relative to the nucleus of M87. The position of the nucleus is: RA=12h 30m 49.4311s, Dec=12d 23m 29.1683s

#	$\Delta RA$ (arcsec)	$\Delta Dec$ (arcsec)	(Kundu et al. 1999) ID	(Sohn et al. 2006) ID
1	10.54	-18.96	---	---
2	-13.12	-19.14	---	---
3	-13.97	17.41	---	---
4	8.44	16.95	85	3104
5	3.09	16.91	73	3101
6	-11.25	16.79	---	---
7	9.01	15.96	80	3105
8	10.76	15.74	89	3002
9	5.93	15.52	66	3001
10	-11.13	15.56	88	---
11	-12.43	15.45	100	---
12	12.92	14.73	96	3005
13	-1.27	14.49	53	---
14	-19.07	12.99	---	---
15	-14.40	12.97	90	---
16	-15.04	12.95	99	---
17	1.51	12.90	48	---
18	12.46	12.80	76	3004
19	18.72	12.41	---	3010
20	-0.28	12.20	41	---
21	1.34	12.20	42	---
22	-9.46	12.06	59	---
23	-4.68	12.02	47	4010
24	18.30	11.92	---	3114
25	-1.04	11.44	35	4014
26	-2.67	10.53	30	4012
27	-1.79	10.55	---	---
28	6.13	10.47	40	3102
29	14.28	9.52	68	3006
30	7.70	8.28	---	---
31	-13.47	7.87	60	4003
32	11.15	7.52	---	---
33	18.37	7.40	97	3008
34	-11.59	6.89	50	4005
35	10.78	6.81	46	3106
36	-2.78	6.47	20	4011
37	-7.85	6.21	26	4007
38	-14.19	6.06	57	---
39	8.37	5.99	27	---
40	3.26	5.61	18	---
41	3.98	5.16	17	---
42	18.06	4.85	81	3112
43	-15.76	4.56	64	---
44	14.50	4.44	54	3109
45	16.56	3.93	67	3007
46	1.36	3.45	7	---
47	-1.35	2.63	3	4013
48	17.21	2.50	71	3111
49	4.30	2.38	10	---
50	-5.94	1.55	15	---
51	5.53	1.48	---	---
52	-6.78	0.93	19	4008
53	11.31	0.85	33	---
54	1.51	0.82	2	---
55	2.94	0.88	4	---
56	3.48	0.06	5	---
57	-5.49	-0.76	12	---

58	-1.15	-0.88	1	---
59	-4.72	-1.61	9	---
60	-15.92	-2.29	62	4001
61	-17.59	-2.68	74	---
62	9.32	-2.74	25	---
63	15.45	-3.06	61	---
64	-17.18	-3.33	70	---
65	1.11	-3.46	6	---
66	19.12	-3.42	---	---
67	3.43	-4.26	13	---
68	0.05	-4.41	8	4015
69	18.93	-4.47	91	---
70	2.53	-4.60	11	4016
71	-11.74	-4.87	44	4004
72	9.48	-5.28	---	---
73	-10.26	-5.95	37	---
74	0.24	-6.14	16	---
75	-7.22	-5.98	23	---
76	-10.55	-6.17	39	4006
77	-14.04	-6.34	56	4002
78	-8.24	-6.72	28	---
79	8.68	-6.98	32	---
80	9.48	-7.40	---	---
81	-5.30	-7.94	24	4009
82	1.80	-7.97	---	---
83	-2.55	-8.04	22	---
84	-8.20	-8.27	34	---
85	8.44	-8.46	---	---
86	-12.06	-8.51	52	---
87	-8.40	-8.91	---	---
88	16.43	-9.63	86	---
89	8.45	-9.98	---	---
90	5.97	-10.29	38	---
91	-7.65	-10.90	49	---
92	-4.10	-11.44	---	---
93	2.73	-12.01	43	---
94	-18.35	-12.10	---	---
95	-9.82	-12.38	63	---
96	11.93	-13.04	75	---
97	-9.39	-13.23	65	---
98	-1.36	-13.43	51	---
99	9.87	-14.00	72	---
100	-4.41	-14.27	55	---
101	-18.00	-14.58	---	---
102	-16.10	-14.60	---	---
103	-12.42	-15.16	94	---
104	15.17	-15.93	---	---
105	9.73	-16.77	92	---
106	9.94	-17.21	---	---
107	5.33	-17.20	78	---
108	-14.03	-17.29	---	---
109	16.22	-17.51	---	---
110	-2.14	-17.61	77	---
111	-4.95	-17.85	82	---
112	-0.69	-18.45	83	---
113	0.31	18.20	79	---
114	-5.77	18.02	87	---
115	14.98	17.97	---	3110

Table C2: Photometrical data for the M87 Globular Clusters. Magnitudes are corrected using the simulations.

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M [mag AB]	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
1	.....	.....	26.18* ±0.44	24.30 ±0.14	23.25 ±0.16	23.40 ±0.05	22.64 ±0.07	23.06 ±0.10	23.00 ±0.06	.....	22.58 ±0.11	22.60 ±0.10	22.58* ±0.13	< 21.36	.....
2	.....	.....	.....	22.80 ±0.06	22.46 ±0.06	22.07 ±0.02	21.72 ±0.03	21.80 ±0.02	21.66 ±0.02	21.21 ±0.07	.....	21.18 ±0.04	20.98 ±0.04	.....	< 21.01
3	.....	.....	.....	.....	.....	< 24.18	24.81* ±0.15	.....	24.18 ±0.13	.....	.....	23.24 ±0.15	< 22.27	< 21.22	.....
4	27.55 ±0.00	.....	< 24.93	< 23.61	< 23.19	23.60 ±0.05	23.15 ±0.09	23.43* ±0.00	23.08 ±0.08	< 21.94	22.71 ±0.11	22.47 ±0.09	< 22.28	< 21.40	20.72* ±0.20
5	27.42 ±0.00	.....	< 24.93	< 23.61	< 23.20	23.81* ±0.09	22.54 ±0.06	< 24.29	23.44 ±0.11	.....	< 23.19	22.84 ±0.15	< 22.26	< 21.39	< 21.05
6	.....	.....	.....	.....	.....	25.01* ±0.00	24.45* ±0.15	.....	24.08 ±0.12	.....	.....	23.45 ±0.16	< 22.27	< 21.40	< 21.05
7	28.08 ±0.00	.....	< 24.93	< 23.61	< 23.19	23.99* ±0.08	23.57 ±0.14	23.69* ±0.00	23.71 ±0.12	< 21.94	23.71* ±0.23	23.09 ±0.14	23.22* ±0.00	< 21.40	< 20.99
8	27.39 ±0.31	.....	< 24.93	< 24.32	< 23.19	23.53 ±0.05	23.29 ±0.14	.....	23.16 ±0.08	< 21.94	22.18 ±0.09	22.77 ±0.12	23.08* ±0.00	< 21.40	< 20.99
9	25.40 ±0.08	.....	23.28 ±0.03	22.26 ±0.03	21.76 ±0.03	21.58 ±0.01	21.31 ±0.04	21.29 ±0.01	21.12 ±0.02	20.60 ±0.05	20.89 ±0.03	20.74 ±0.03	20.58 ±0.03	20.70 ±0.09	20.71* ±0.19
10	.....	.....	.....	.....	.....	23.64 ±0.06	23.33 ±0.06	.....	23.26 ±0.08	.....	.....	22.67 ±0.11	23.22* ±0.36	< 21.40	< 21.05
11	.....	.....	.....	.....	.....	23.13 ±0.03	22.93 ±0.05	.....	22.61 ±0.05	.....	.....	22.13 ±0.07	22.06 ±0.08	< 21.22	< 21.05
12	25.76 ±0.09	.....	23.56 ±0.06	22.81 ±0.06	21.91 ±0.06	22.44 ±0.03	22.18 ±0.06	21.85 ±0.03	22.04 ±0.03	22.23* ±0.14	21.66 ±0.06	21.68 ±0.05	21.54 ±0.05	< 21.44	< 21.04
13	.....	.....	< 24.93	< 23.62	< 23.20	23.43 ±0.06	23.22 ±0.06	23.33 ±0.06	23.11 ±0.08	< 21.92	23.12* ±0.16	22.63 ±0.12	23.78* ±0.59	< 21.39	< 21.02
14	.....	.....	< 24.85	< 23.53	< 23.21	23.28 ±0.04	22.93 ±0.04	23.04 ±0.06	22.81 ±0.06	< 21.94	.....	22.24 ±0.08	21.93 ±0.07	20.78* ±0.24	.....
15	.....	.....	24.36 ±0.09	23.13 ±0.08	22.45 ±0.06	22.44 ±0.02	22.18 ±0.02	22.20 ±0.03	22.04 ±0.03	21.73* ±0.14	.....	21.65 ±0.05	21.43 ±0.05	< 21.22	.....
16	.....	.....	< 24.90	< 23.62	< 23.22	< 24.18	< 24.31	< 24.30	24.65 ±0.15	< 21.94	.....	22.77 ±0.10	21.98 ±0.07	< 21.22	.....
17	.....	.....	< 24.93	< 23.62	< 23.20	23.26 ±0.06	22.88 ±0.07	22.87 ±0.04	22.69 ±0.06	< 21.92	22.22 ±0.07	22.21 ±0.09	< 22.10	< 21.39	< 21.05
18	26.93 ±0.21	.....	< 25.08	23.13 ±0.07	.....	22.99 ±0.04	22.78 ±0.09	.....	22.54 ±0.04	23.54* ±0.21	.....	22.04 ±0.07	21.75 ±0.06	< 21.44	< 20.99
19	26.54 ±0.16	.....	24.61 ±0.12	23.86 ±0.11	23.20 ±0.11	23.43 ±0.05	23.27 ±0.08	23.17 ±0.09	23.22 ±0.07	.....	23.24 ±0.20	22.87 ±0.10	< 22.29	< 21.44	< 21.04
20	.....	.....	23.92 ±0.05	22.80 ±0.06	21.98 ±0.04	22.01 ±0.02	21.57 ±0.02	21.56 ±0.02	21.39 ±0.02	20.92 ±0.09	21.13 ±0.04	20.86 ±0.04	20.70 ±0.04	20.60 ±0.10	20.61* ±0.19



Table C2: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
[mag AB]															
21	.....	.....	< 24.93	< 23.62	< 23.19	23.57 ±0.07	23.54 ±0.09	23.42 ±0.06	23.22 ±0.09	< 21.92	23.71* ±0.21	22.94 ±0.14	< 22.26	< 21.39	< 21.05
22	< 26.37	< 26.90	< 24.90	< 23.61	< 23.22	23.43 ±0.06	23.13 ±0.05	23.24 ±0.05	22.97 ±0.06	< 21.93	22.59 ±0.11	22.39 ±0.10	23.30* ±0.34	< 21.40	< 21.05
23	< 26.36	< 26.92	< 24.92	< 23.61	< 23.25	25.32* ±0.38	23.87 ±0.10	23.73 ±0.08	23.72 ±0.11	< 21.92	< 23.17	23.50 ±0.16	< 22.27	< 21.40	< 21.02
24	27.66 ±0.00	.....	26.36* ±0.31	24.16 ±0.12	23.04 ±0.10	23.23 ±0.04	22.87 ±0.06	22.92 ±0.06	22.86 ±0.06	.....	22.50 ±0.11	22.30 ±0.08	21.88 ±0.07	22.46* ±0.42	< 21.04
25	< 26.39	.....	< 24.93	< 23.62	< 23.19	23.36 ±0.06	23.13 ±0.08	23.16 ±0.06	23.07 ±0.08	< 21.92	22.96 ±0.14	22.57 ±0.12	23.63* ±0.65	< 21.39	< 21.02
26	26.40* ±0.00	25.05 ±0.22	23.89 ±0.05	22.90 ±0.08	22.40 ±0.06	22.30 ±0.05	22.05 ±0.04	22.08 ±0.03	22.00 ±0.05	21.44* ±0.13	21.76 ±0.05	21.61 ±0.09	21.50 ±0.10	< 21.33	23.70* ±0.44
27	< 26.39	< 26.87	< 24.92	< 23.62	< 23.19	23.43 ±0.09	23.20 ±0.08	23.23 ±0.06	23.19 ±0.14	< 21.92	23.18* ±0.17	22.65 ±0.18	< 22.06	< 21.33	< 21.59
28	27.68 ±0.00	.....	< 24.93	< 23.61	< 23.25	23.66 ±0.08	23.00 ±0.10	23.29 ±0.06	23.13 ±0.09	< 21.93	23.00 ±0.16	22.40 ±0.11	23.05* ±0.00	< 21.40	< 21.59
29	26.15 ±0.13	.....	23.19 ±0.04	21.89 ±0.03	21.00 ±0.02	21.22 ±0.01	20.87 ±0.02	20.72 ±0.01	20.69 ±0.01	20.18 ±0.04	20.04 ±0.02	20.16 ±0.02	19.86 ±0.02	19.85 ±0.05	19.90 ±0.11
30	.....	.....	< 24.93	< 23.61	< 23.25	25.30* ±0.26	24.04 ±0.21	23.98 ±0.11	23.75 ±0.13	< 21.92	23.55* ±0.16	22.93 ±0.16	< 22.24	< 21.40	< 21.59
31	28.21* ±0.00	25.77 ±0.55	24.31 ±0.10	23.40* ±0.11	22.61 ±0.09	22.45 ±0.05	22.14 ±0.05	22.15 ±0.03	21.99 ±0.08	21.74* ±0.14	21.74 ±0.05	21.40 ±0.11	21.15 ±0.12	23.79* ±0.68	< 20.76
32	.....	.....	< 24.92	< 23.61	< 23.19	< 24.15	24.01 ±0.21	24.32* ±0.15	23.84 ±0.14	< 21.93	< 23.17	23.11 ±0.16	< 22.24	< 21.40	< 21.04
33	26.84 ±0.21	.....	24.29 ±0.09	23.51 ±0.09	22.73 ±0.08	23.04 ±0.05	22.61 ±0.09	22.50 ±0.05	22.47 ±0.05	.....	22.34 ±0.13	22.31 ±0.09	< 22.26	< 21.43	< 21.00
34	.....	25.67 ±0.27	< 24.63	< 23.45	< 23.13	23.30 ±0.09	23.05 ±0.09	23.10 ±0.10	23.14 ±0.14	< 21.82	22.86 ±0.14	22.68 ±0.17	25.64* ±0.61	< 21.13	< 20.76
35	27.62 ±0.00	.....	< 24.92	< 23.62	< 23.19	23.15 ±0.05	22.84 ±0.09	22.87 ±0.05	22.78 ±0.07	< 21.93	22.49 ±0.10	22.35 ±0.11	21.97* ±0.10	< 21.40	< 21.04
36	< 26.39	25.82 ±0.33	24.38 ±0.10	23.29 ±0.10	22.81 ±0.10	22.74 ±0.06	22.45 ±0.05	22.53 ±0.06	22.32 ±0.08	21.45* ±0.20	22.09 ±0.09	21.99 ±0.12	21.68 ±0.11	< 21.33	22.85* ±0.44
37	25.94 ±0.10	25.52 ±0.18	23.77 ±0.07	22.60 ±0.05	22.00 ±0.05	21.91 ±0.05	21.55 ±0.03	21.66 ±0.04	21.38 ±0.04	21.02 ±0.11	21.17 ±0.05	20.93 ±0.06	20.76 ±0.06	20.69 ±0.16	20.62 ±0.10
38	< 26.33	< 26.12	< 24.63	< 23.45	26.41* ±0.57	23.56 ±0.08	23.30 ±0.12	23.31 ±0.11	23.34 ±0.26	< 21.82	22.94 ±0.15	22.89 ±0.26	25.81* ±0.61	< 21.13	.....
39	.....	.....	< 24.92	< 23.62	< 23.19	< 24.15	23.41 ±0.13	23.74 ±0.11	23.61 ±0.12	< 21.92	< 23.15	22.96 ±0.16	< 22.24	< 21.40	< 21.59
40	.....	.....	23.57 ±0.04	22.41 ±0.04	21.75 ±0.04	21.64 ±0.03	21.33 ±0.05	21.30 ±0.02	21.11 ±0.03	20.29 ±0.05	20.79 ±0.03	20.65 ±0.03	20.40 ±0.05	20.35 ±0.10	20.51 ±0.09
41	.....	.....	< 24.94	< 23.61	< 23.15	< 24.15	25.65* ±0.66	25.98* ±0.50	23.87 ±0.14	< 21.92	< 23.16	23.41 ±0.19	< 22.06	< 21.33	< 21.56

Table C2: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
42	27.23 ±0.00	.....	< 25.08	< 24.36	25.36* ±0.46	23.71 ±0.07	23.19 ±0.09	23.35 ±0.09	23.11 ±0.08	.....	23.17 ±0.15	22.51 ±0.10	22.29* ±0.10	< 21.43	< 21.00
43	< 26.16	< 25.92	< 24.79	< 23.63	23.72* ±0.31	23.16 ±0.06	22.80 ±0.08	22.88 ±0.05	22.99 ±0.18	< 21.82	22.41 ±0.09	22.25 ±0.17	21.84 ±0.13	< 21.13	.....
44	27.35 ±0.00	.....	< 24.70	.....	..... 22.53 ±0.03	22.31 ±0.11	..... 22.31	..... 22.19	22.19 ±0.04	23.72* ±0.29	22.13 ±0.08	21.70 ±0.05	21.46 ±0.06	23.58* ±0.49	< 21.00
45	25.89 ±0.11	.....	23.64 ±0.07	22.74 ±0.05	21.56 ±0.04	21.95 ±0.02	21.62 ±0.06	21.59 ±0.02	21.47 ±0.02	21.00 ±0.07	.....	20.90 ±0.03	20.67 ±0.03	20.49 ±0.08	20.46 ±0.14
46	26.04 ±0.76	26.34* ±0.30	< 24.94	25.19* ±0.05	23.23* ±0.14	23.05 ±0.08	22.72 ±0.11	22.78 ±0.09	22.75 ±0.11	20.98 ±0.16	22.08 ±0.08	22.26 ±0.13	21.68 ±0.22	21.80* ±0.37	21.20* ±0.20
47	< 26.37	25.69 ±0.30	24.00 ±0.10	22.88 ±0.08	22.20 ±0.10	22.31 ±0.13	21.86 ±0.06	21.89 ±0.07	21.84 ±0.20	20.78 ±0.14	21.37 ±0.07	21.35 ±0.21	20.96 ±0.12	21.01* ±0.20	20.67 ±0.14
48	27.43 ±0.00	.....	24.36 ±0.09	23.65 ±0.10	22.69 ±0.08	23.11 ±0.05	23.11 ±0.21	23.03 ±0.08	22.80 ±0.07	< 21.92	.....	22.49 ±0.11	23.06* ±0.21	< 21.42	< 21.06
49	.....	.....	23.31 ±0.04	22.09 ±0.04	21.55 ±0.04	21.24 ±0.02	20.90 ±0.03	20.94 ±0.03	20.81 ±0.02	20.17 ±0.04	20.42 ±0.03	20.20 ±0.03	19.89 ±0.03	19.87 ±0.07	19.84 ±0.09
50	< 26.31	< 26.49	< 24.67	< 23.50	< 23.05	23.31 ±0.06	22.90 ±0.11	23.05 ±0.14	22.54 ±0.11	< 21.92	22.61 ±0.15	22.15 ±0.12	23.55* ±0.67	< 21.35	< 21.51
51	.....	.....	< 24.94	< 23.61	< 23.15	< 24.08	24.33* ±0.24	26.52* ±0.55	23.88 ±0.15	< 21.92	< 23.14	23.17 ±0.21	< 22.15	< 21.32	< 21.54
52	< 26.31	25.87 ±0.33	< 24.83	23.62* ±0.15	22.85* ±0.09	22.95 ±0.06	22.67 ±0.13	22.75 ±0.14	22.57 ±0.11	23.10* ±0.00	22.18 ±0.09	22.17 ±0.15	21.76 ±0.14	< 21.35	23.37* ±0.57
53	.....	.....	< 24.92	< 23.62	< 23.25	23.72 ±0.10	23.67 ±0.33	23.58 ±0.09	23.54 ±0.15	< 21.92	24.07* ±0.34	23.19 ±0.21	< 22.15	< 21.32	< 20.99
54	< 26.37	< 26.21	< 24.94	< 23.61	< 23.15	24.54* ±0.57	23.51 ±0.20	23.57 ±0.15	22.56 ±0.26	20.07 ±0.13	22.44 ±0.18	22.20 ±0.27	< 21.84	< 21.14	< 21.48
55	< 26.37	< 26.75	< 24.94	< 23.61	< 23.15	25.48* ±0.61	23.55 ±0.17	23.43 ±0.15	23.32 ±0.31	21.98* ±0.29	22.77 ±0.15	22.97 ±0.40	< 21.84	< 21.14	< 21.48
56	< 26.32	< 26.75	< 24.94	< 23.61	< 23.15	23.88* ±0.20	23.67 ±0.17	23.52 ±0.15	23.74 ±0.34	< 21.55	24.78* ±0.51	23.14 ±0.33	< 21.84	< 21.14	26.55* ±0.71
57	< 26.31	< 26.49	< 24.83	< 23.50	25.22* ±0.14	23.12 ±0.07	22.81 ±0.11	22.83 ±0.14	22.67 ±0.10	22.85* ±0.00	22.04 ±0.08	22.04 ±0.12	21.53 ±0.13	< 21.35	23.73* ±0.57
58	.....	.....	< 24.67	< 23.50	< 23.05	22.72 ±0.11	22.73 ±0.13	22.63 ±0.13	21.60 ±0.15	< 21.55	22.25 ±0.15	21.30 ±0.21	< 21.84	< 21.14	< 21.48
59	< 26.31	< 26.49	< 24.67	< 23.50	< 23.05	23.92* ±0.12	23.47 ±0.16	23.56 ±0.24	23.40 ±0.15	< 21.92	24.61* ±0.31	22.79 ±0.21	< 22.12	< 21.35	< 21.54
60	< 26.37	26.37 ±0.00	< 24.87	< 23.60	< 23.19	23.38 ±0.06	23.21 ±0.05	23.19 ±0.05	23.19 ±0.08	< 21.93	23.02 ±0.14	22.82 ±0.13	22.34* ±0.11	< 21.34	.....
61	< 26.37	< 26.91	< 24.87	< 23.60	< 23.19	24.18* ±0.11	23.75 ±0.09	23.72 ±0.08	23.76 ±0.10	.....	25.06* ±0.00	23.15 ±0.17	< 22.25	< 21.34	.....
62	.....	.....	24.05 ±0.05	22.91 ±0.06	22.31 ±0.06	22.33 ±0.04	21.06 ±0.05	22.08 ±0.03	21.83 ±0.04	21.35* ±0.09	21.59 ±0.05	21.36 ±0.06	21.22 ±0.07	21.06* ±0.18	21.12 ±0.16

Table C2: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
63	.....	.....	< 24.92	< 23.61	< 23.25	24.20*	23.08	27.50*	23.79	< 21.93	25.40*	23.32	< 22.26	< 21.42	< 21.06
						±0.10	±0.20	±0.03	±0.11		±0.00	±0.16			
64	< 26.37	< 26.93	< 24.60	23.45*	22.42	22.54	22.14	22.17	21.99	.....	21.65	21.38	21.13	20.76	.....
				±0.11	±0.06	±0.03	±0.02	±0.02	±0.03		±0.04	±0.05	±0.05	±0.11	
65	< 26.32	< 26.75	< 24.86	< 23.60	< 23.15	23.41	23.15	23.04	23.17	< 21.55	22.62	22.26	22.35*	< 21.14	23.28*
						±0.23	±0.11	±0.07	±0.30		±0.20	±0.27	±0.20		±0.56
66	.....	.....	25.29*	< 24.35	< 23.48	< 24.18	22.01	24.52	24.25	.....	< 23.54	23.46	< 22.26	< 21.42	< 21.06
			±0.16				±0.09	±0.24	±0.16			±0.16			
67	< 26.32	< 26.75	< 24.92	< 23.61	< 23.17	23.95*	23.59	23.89*	23.76	< 21.91	23.63*	22.90	< 22.13	< 21.14	< 21.52
						±0.26	±0.17	±0.14	±0.34		±0.20	±0.18			
68	25.82	25.54	23.89	22.62	22.14	21.91	21.55	21.56	21.39	20.81	21.00	20.78	20.48	20.33	20.31
	±0.13	±0.21	±0.05	±0.06	±0.06	±0.03	±0.03	±0.02	±0.03	±0.07	±0.07	±0.04	±0.04	±0.08	±0.10
69	.....	.....	23.60	22.75	21.93	22.19	21.64	21.77	21.78	.....	21.75	21.36	21.16	20.92	< 21.05
			±0.05	±0.05	±0.05	±0.02	±0.06	±0.03	±0.02		±0.05	±0.05	±0.05	±0.17	
70	< 26.32	25.69	< 24.86	23.51*	22.98*	22.84	22.60	22.71	22.46	< 21.91	22.22	21.98	21.77	< 21.30	< 21.52
		±0.30		±0.11	±0.11	±0.05	±0.09	±0.06	±0.07		±0.10	±0.11	±0.11		
71	< 26.37	26.70*	< 24.87	< 23.59	< 23.19	23.46	23.26	23.34	23.33	< 21.93	23.11*	22.99	< 22.28	< 21.38	< 20.97
		±0.31				±0.06	±0.07	±0.07	±0.08		±0.14	±0.11			
72	.....	.....	< 24.92	23.93*	23.20*	22.94	.....	22.65	22.48	22.79*	22.19	21.86	21.64	< 21.42	21.69*
				±0.13	±0.14	±0.04		±0.04	±0.06	±0.48	±0.09	±0.08	±0.09		±0.22
73	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	24.59*	23.87	23.84	23.77	< 21.94	24.56*	23.10	< 22.23	< 21.41	< 21.56
						±0.35	±0.12	±0.10	±0.12		±0.54	±0.16			
74	< 26.37	< 26.85	24.33	22.63	21.71	21.41	20.71	20.68	20.53	19.50	19.58	19.11	18.68	18.55	18.55
			±0.08	±0.06	±0.04	±0.02	±0.02	±0.01	±0.02	±0.03	±0.01	±0.02	±0.01	±0.03	±0.07
75	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	25.45*	23.84	23.78	23.79	< 21.92	< 23.13	23.19	< 22.23	< 21.41	< 21.55
						±0.00	±0.11	±0.10	±0.12			±0.16			
76	< 26.37	26.43	< 24.90	< 23.61	< 23.20	23.68	23.40	23.58	23.48	< 21.94	23.30*	23.04	< 22.23	< 21.41	< 21.56
		±0.17				±0.07	±0.08	±0.08	±0.11		±0.14	±0.17			
77	< 26.37	26.17	< 24.91	< 23.61	< 23.14	23.15	22.97	22.99	22.70	< 21.94	22.70	22.30	< 22.28	< 21.38	< 20.97
		±0.00				±0.03	±0.05	±0.04	±0.05		±0.10	±0.08			
78	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	23.75*	23.35	23.42	23.08	< 21.92	23.16*	22.50	22.65*	< 21.41	< 21.63
						±0.07	±0.07	±0.06	±0.09		±0.16	±0.13	±0.15		
79	.....	.....	< 24.93	< 23.61	< 23.21	23.25	.....	22.96	22.91	< 21.93	22.62	22.42	24.09*	< 21.42	< 21.25
						±0.06		±0.06	±0.11		±0.12	±0.11	±0.00		
80	.....	.....	< 24.93	< 23.62	< 23.21	< 24.16	< 24.13	< 24.28	24.04	< 21.93	< 23.13	23.39	< 22.24	< 21.42	< 21.25
									±0.17			±0.18			
81	25.63	24.93	23.36	22.33	21.73	21.67	21.44	21.39	21.26	20.68	20.93	20.79	20.58	20.49	20.40
	±0.06	±0.12	±0.04	±0.04	±0.03	±0.02	±0.03	±0.02	±0.02	±0.04	±0.03	±0.04	±0.06	±0.10	±0.10
82	< 26.37	.....	< 24.86	< 23.60	< 23.15	< 24.06	.....	23.63	22.87	< 21.91	22.40	21.79	21.61	< 21.30	20.01
								±0.11	±0.10		±0.11	±0.10	±0.10		±0.08
83	26.09	< 26.85	< 24.70	23.41*	22.70	22.49	22.27	22.21	21.94	< 21.92	21.67	21.39	21.21	21.09*	20.92
	±0.22			±0.12	±0.10	±0.04	±0.05	±0.04	±0.05		±0.06	±0.07	±0.08	±0.18	±0.14

Table C2: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
84	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	23.70 ±0.07	23.41 ±0.08	23.63 ±0.09	23.62 ±0.13	< 21.92	23.30* ±0.16	23.04 ±0.17	< 22.23	< 21.41	< 21.56
85	< 26.32	< 26.75	< 24.93	< 23.62	< 23.21	< 24.16	< 24.13	< 24.28	22.56 ±0.06	< 21.93	< 23.16	21.32 ±0.05	< 22.24	< 21.42	19.66 ±0.07
86	< 26.37	< 26.90	< 24.91	< 23.61	< 23.14	23.51 ±0.07	23.22 ±0.07	23.22 ±0.05	22.97 ±0.06	< 21.94	22.46 ±0.09	22.29 ±0.08	22.01 ±0.08	< 21.38	< 20.97
87	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	23.40 ±0.06	23.30 ±0.07	23.21 ±0.06	22.84 ±0.07	< 21.92	22.63 ±0.11	22.43 ±0.13	< 22.23	< 21.41	24.80* ±0.53
88	.....	.....	< 24.92	< 23.62	< 23.26	24.24* ±0.11	23.65 ±0.17	23.77 ±0.10	23.69 ±0.10	< 21.93	23.42* ±0.20	23.12 ±0.15	< 22.27	< 21.46	< 21.05
89	.....	.....	< 24.93	< 23.62	< 23.21	< 24.16	< 24.39	< 24.28	24.13 ±0.18	< 21.94	< 23.16	23.38 ±0.18	< 22.24	< 21.42	< 21.25
90	.....	.....	< 24.93	< 23.62	23.92* ±0.00	23.38 ±0.08	23.21 ±0.17	23.02 ±0.05	22.88 ±0.09	< 21.94	22.63 ±0.11	22.32 ±0.10	21.91 ±0.11	< 21.42	25.39* ±0.57
91	< 26.37	< 26.85	< 24.93	< 23.61	< 23.25	23.76 ±0.07	.....	23.39 ±0.06	23.40 ±0.11	< 21.92	23.06* ±0.16	22.69 ±0.14	22.67* ±0.22	< 21.41	< 20.97
92	.....	.....	< 24.93	< 23.61	< 23.25	23.60 ±0.08	22.97 ±0.09	23.48 ±0.06	23.32 ±0.09	< 21.92	23.12* ±0.16	22.72 ±0.14	22.31* ±0.15	< 21.41	< 20.97
93	.....	.....	< 24.86	< 23.61	< 23.25	23.46 ±0.05	23.44 ±0.32	23.22 ±0.06	23.05 ±0.06	< 21.92	23.12* ±0.16	22.57 ±0.11	24.51* ±0.02	< 21.40	< 21.05
94	.....	.....	.....	.....	.....	25.74* ±0.12	23.87 ±0.11	.....	23.88 ±0.10	.....	.....	23.32 ±0.15	< 22.25	< 21.39	.....
95	< 26.37	< 26.90	24.80* ±0.00	23.60* ±0.12	22.41 ±0.06	22.39 ±0.02	21.57 ±0.03	22.03 ±0.02	21.82 ±0.02	21.36* ±0.08	21.47 ±0.04	21.25 ±0.04	20.94 ±0.05	20.80 ±0.14	< 21.01
96	.....	.....	.....	.....	.....	23.07 ±0.04	21.86 ±0.06	22.90 ±0.05	22.51 ±0.04	24.00* ±0.00	22.49 ±0.10	22.02 ±0.05	21.73 ±0.07	< 21.40	< 21.03
97	< 26.37	.....	< 24.87	25.32* ±0.19	< 23.21	23.37 ±0.05	22.90 ±0.10	23.18 ±0.05	23.00 ±0.07	< 21.94	22.75 ±0.11	22.58 ±0.10	< 22.26	< 21.41	< 21.01
98	.....	.....	23.95 ±0.06	22.39 ±0.04	21.57 ±0.03	21.48 ±0.01	21.05 ±0.02	21.09 ±0.01	20.93 ±0.01	20.37 ±0.03	20.52 ±0.02	20.30 ±0.02	20.01 ±0.02	19.77 ±0.05	19.69 ±0.11
99	.....	.....	.....	.....	.....	22.71 ±0.03	21.74 ±0.05	.....	22.27 ±0.03	22.64* ±0.00	22.03 ±0.07	21.81 ±0.06	21.58 ±0.07	23.62* ±0.51	< 21.03
100	.....	.....	24.01 ±0.05	23.24 ±0.10	22.67 ±0.08	22.57 ±0.03	22.40 ±0.06	22.42 ±0.03	22.26 ±0.04	22.65* ±0.00	21.95 ±0.06	21.90 ±0.06	21.65 ±0.06	23.47* ±0.49	< 21.04
101	.....	.....	.....	.....	.....	23.95 ±0.08	23.07 ±0.07	.....	23.41 ±0.08	.....	.....	22.77 ±0.12	< 22.25	23.89* ±0.43	.....
102	< 26.37	.....	< 24.87	< 23.61	.....	23.73 ±0.05	23.09 ±0.07	23.55 ±0.07	23.40 ±0.08	.....	.....	23.01 ±0.13	< 22.25	< 21.39	.....
103	.....	.....	22.48 ±0.02	21.41 ±0.02	21.00 ±0.02	20.75 ±0.01	20.44 ±0.01	20.50 ±0.01	20.34 ±0.01	19.99 ±0.02	20.09 ±0.01	19.94 ±0.02	19.73 ±0.02	19.74 ±0.05	.....
104	.....	.....	< 25.09	< 24.33	< 23.52	24.93* ±0.00	23.96 ±0.14	24.09 ±0.21	24.00 ±0.11	.....	< 23.56	23.21 ±0.12	< 22.26	< 21.40	< 21.04



Table C2: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
[mag AB]															
105	.....	.....	< 25.09	< 24.33	< 23.52	24.31*	23.40	23.95	23.76	.....	< 23.57	23.22	< 22.26	< 21.36	< 21.03
						±0.11	±0.32	±0.18	±0.10			±0.17			
106	.....	.....	23.21	22.20	21.49	21.55	21.14	21.29	21.16	.....	20.55	20.77	20.60	20.54	21.56*
			±0.04	±0.03	±0.03	±0.01	±0.02	±0.02	±0.01		±0.02	±0.03	±0.03	±0.09	±0.34
107	.....	.....	24.95*	24.10	24.10*	23.58	23.43	22.56	23.15	.....	.....	22.69	< 22.26	< 21.36	< 21.05
			±0.12	±0.13	±0.24	±0.06	±0.32	±0.05	±0.07			±0.10			
108	.....	.....	< 24.87	< 23.61	< 23.21	25.70*	24.22	24.02	23.90	< 21.94	.....	23.29	< 22.25	< 21.39	.....
						±0.62	±0.18	±0.11	±0.10			±0.15			
109	.....	.....	< 25.09	< 24.33	< 23.52	24.85*	24.26	< 24.60	23.92	.....	23.78*	23.27	< 22.26	< 21.40	< 21.04
						±0.00	±0.17		±0.10		±0.27	±0.13			
110	.....	.....	.....	.....	.....	23.85*	23.82	.....	23.40	< 21.94	23.75*	22.90	22.94*	< 21.40	< 21.04
						±0.08	±0.18		±0.10		±0.27	±0.13	±0.00		
111	.....	.....	.....	.....	.....	23.67	23.57	.....	23.34	< 21.94	22.95	22.91	< 22.26	< 21.41	< 21.04
						±0.06	±0.15		±0.07		±0.13	±0.11			
112	.....	.....	< 25.11	< 24.33	< 23.56	< 24.12	24.42	23.04	24.13	.....	< 23.15	23.37	< 22.25	< 21.40	23.88*
							±0.22	±0.09	±0.14			±0.19			±0.18
113	.....	.....	< 24.93	< 23.62	< 23.20	24.35*	23.59	.....	23.65	.....	.....	23.05	< 22.26	< 21.39	< 21.05
						±0.14	±0.09		±0.12			±0.14			
114	.....	.....	.....	.....	.....	23.04	22.83	.....	22.63	.....	.....	22.31	22.21*	< 21.40	< 21.02
						±0.04	±0.05		±0.05			±0.08	±0.13		
115	27.79 ±0.00	.....	< 25.08	< 24.32	< 23.47	26.40*	23.93	23.67	23.73	< 21.94	25.60*	23.25	< 22.29	< 21.44	< 21.04
						±0.00	±0.13	±0.09	±0.10		±0.44	±0.14			

Table C3: Photometrical data for the M87 Globular Clusters uncorrected from bias.

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
[mag AB]															
1	.....	.....	25.79 ±0.32	24.52 ±0.16	23.66 ±0.22	23.83 ±0.07	22.84 ±0.08	23.31 ±0.12	23.12 ±0.06	.....	22.79 ±0.14	22.84 ±0.13	22.83 ±0.16	< 21.36	.....
2	.....	.....	25.15 ±0.17	23.21 ±0.09	22.94 ±0.09	22.33 ±0.02	21.90 ±0.03	22.04 ±0.03	21.76 ±0.02	21.96 ±0.13	.....	21.34 ±0.04	21.20 ±0.05	21.40 ±0.22	< 21.01
3	.....	.....	.....	.....	.....	< 24.18	25.08 ±0.19	.....	24.33 ±0.15	.....	.....	23.63 ±0.21	< 22.27	< 21.22	.....
4	27.55 ±0.00	.....	< 24.93	< 23.61	< 23.19	24.10 ±0.07	23.41 ±0.12	23.67 ±0.06	23.21 ±0.09	< 21.94	23.07 ±0.15	22.69 ±0.11	< 22.28	< 21.40	21.56 ±0.39
5	27.42 ±0.00	.....	< 24.93	< 23.61	< 23.20	24.35 ±0.14	22.77 ±0.08	< 24.29	23.59 ±0.12	.....	< 23.19	23.13 ±0.19	< 22.26	< 21.39	< 21.05
6	.....	.....	.....	.....	.....	25.09 ±0.00	24.90 ±0.21	.....	24.25 ±0.14	.....	.....	23.92 ±0.24	< 22.27	< 21.40	< 21.05
7	28.08 ±0.00	.....	< 24.93	< 23.61	< 23.19	24.47 ±0.12	23.85 ±0.18	23.92 ±0.07	23.84 ±0.13	< 21.94	23.72 ±0.23	23.42 ±0.18	23.25 ±0.00	< 21.40	< 20.99
8	27.39 ±0.00	.....	< 24.93	< 24.32	< 23.19	23.98 ±0.07	23.54 ±0.17	24.68 ±0.19	23.28 ±0.09	< 21.94	22.38 ±0.11	23.02 ±0.15	23.11 ±0.00	< 21.40	< 20.99
9	25.40 ±0.00	.....	23.71 ±0.04	22.53 ±0.04	22.09 ±0.04	21.84 ±0.01	21.48 ±0.05	21.52 ±0.02	21.22 ±0.02	21.31 ±0.10	21.09 ±0.04	20.90 ±0.03	20.77 ±0.04	21.32 ±0.15	21.57 ±0.38
10	.....	.....	.....	.....	.....	24.14 ±0.10	23.76 ±0.08	.....	23.37 ±0.09	.....	.....	22.92 ±0.14	23.05 ±0.31	< 21.40	< 21.05
11	.....	.....	.....	.....	.....	23.49 ±0.05	23.28 ±0.06	.....	22.73 ±0.06	.....	.....	22.33 ±0.08	22.48 ±0.11	< 21.22	< 21.05
12	25.76 ±0.00	.....	23.97 ±0.09	22.96 ±0.07	22.26 ±0.08	22.72 ±0.04	22.37 ±0.07	22.07 ±0.04	22.16 ±0.04	22.57 ±0.19	21.84 ±0.07	21.86 ±0.06	21.79 ±0.06	< 21.44	< 21.04
13	.....	.....	< 24.93	< 23.62	< 23.20	23.85 ±0.08	23.61 ±0.09	23.75 ±0.09	23.26 ±0.10	< 21.92	23.43 ±0.21	22.90 ±0.15	23.24 ±0.40	< 21.39	< 21.02
14	.....	.....	< 24.85	< 23.53	< 23.21	23.66 ±0.06	23.28 ±0.05	23.40 ±0.08	22.93 ±0.06	< 21.94	.....	22.45 ±0.09	22.37 ±0.10	21.99 ±0.62	.....
15	.....	.....	25.00 ±0.16	23.56 ±0.12	22.94 ±0.10	22.73 ±0.03	22.46 ±0.03	22.47 ±0.03	22.15 ±0.03	22.41 ±0.25	.....	21.84 ±0.06	21.70 ±0.06	< 21.22	.....
16	.....	.....	< 24.90	< 23.62	< 23.22	< 24.18	< 24.31	< 24.30	24.86 ±0.18	< 21.94	.....	23.02 ±0.13	22.39 ±0.10	< 21.22	.....
17	.....	.....	< 24.93	< 23.62	< 23.20	23.65 ±0.09	23.24 ±0.10	23.20 ±0.06	22.83 ±0.07	< 21.92	22.56 ±0.10	22.46 ±0.12	< 22.10	< 21.39	< 21.05
18	26.93 ±0.00	.....	< 25.08	23.29 ±0.08	24.06 ±0.00	23.33 ±0.05	23.00 ±0.11	22.18 ±0.04	22.66 ±0.05	22.92 ±0.12	21.49 ±0.06	22.24 ±0.09	22.12 ±0.09	< 21.44	< 20.99
19	26.54 ±0.00	.....	25.17 ±0.19	24.09 ±0.13	23.67 ±0.16	23.85 ±0.07	23.53 ±0.09	23.43 ±0.11	23.36 ±0.08	.....	23.46 ±0.24	23.12 ±0.13	< 22.29	< 21.44	< 21.04
20	.....	.....	24.51 ±0.09	23.18 ±0.09	22.36 ±0.05	22.29 ±0.03	21.82 ±0.03	21.80 ±0.02	21.50 ±0.02	21.68 ±0.17	21.35 ±0.05	21.03 ±0.04	20.89 ±0.05	21.26 ±0.18	20.94 ±0.13
21	.....	.....	< 24.93	< 23.62	< 23.19	24.08	24.07	23.88	23.38	< 21.92	23.80	23.23	< 22.26	< 21.39	< 21.05

Table C3: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
22	< 26.37	< 26.90	< 24.90	< 23.61	< 23.22	±0.11 23.85	±0.15 23.52	±0.09 23.65	±0.11 23.09	< 21.93	±0.23 22.96	±0.19 22.63	22.78	< 21.40	< 21.05
23	< 26.36	< 26.92	< 24.92	< 23.61	< 23.25	±0.09 24.79	±0.07 24.42	±0.08 24.23	±0.07 23.88	< 21.92	±0.16 < 23.17	±0.12 23.97	±0.22 < 22.27	< 21.40	< 21.02
24	27.66 ±0.00	.....	25.70 ±0.18	24.42 ±0.15	23.49 ±0.15	23.62 ±0.06	23.11 ±0.07	23.18 ±0.08	22.98 ±0.07	.....	22.68 ±0.13	22.52 ±0.10	22.28 ±0.10	22.93 ±0.59	< 21.04
25	< 26.39	.....	< 24.93	< 23.62	< 23.19	23.79	23.54	23.54	23.21	< 21.92	23.32	22.85	22.70	< 21.39	< 21.02
26	26.90 ±0.10	25.60 ±0.34	24.45 ±0.08	23.30 ±0.11	22.89 ±0.10	22.59 ±0.06	22.33 ±0.05	22.35 ±0.03	22.11 ±0.06	22.24 ±0.26	22.04 ±0.07	21.82 ±0.11	21.82 ±0.13	< 21.33	< 20.99
27	< 26.39	< 26.87	< 24.92	< 23.62	< 23.19	23.93	23.64	23.65	23.32	< 21.92	23.49	22.97	< 22.06	< 21.33	< 21.59
28	27.68 ±0.00	.....	< 24.93	< 23.61	< 23.25	±0.14 24.19	±0.12 23.22	±0.09 23.71	±0.15 23.27	< 21.93	±0.22 23.35	±0.23 22.65	23.08	< 21.40	< 21.04
29	26.15 ±0.00	.....	23.58 ±0.06	22.03 ±0.03	21.29 ±0.03	21.46 ±0.01	21.05 ±0.03	20.92 ±0.02	20.80 ±0.01	20.78 ±0.07	20.20 ±0.03	20.31 ±0.02	20.03 ±0.02	20.17 ±0.07	20.56 ±0.19
30	.....	.....	< 24.93	< 23.61	< 23.25	24.81	24.34	24.49	23.86	< 21.92	23.72	23.19	< 22.24	< 21.40	< 21.04
31	27.67 ±0.05	26.38 ±0.83	24.96 ±0.17	23.83 ±0.16	23.13 ±0.14	22.75 ±0.06	22.44 ±0.06	22.41 ±0.03	22.14 ±0.10	22.41 ±0.25	22.03 ±0.07	21.66 ±0.13	21.40 ±0.15	22.83 ±0.33	< 20.76
32	.....	.....	< 24.92	< 23.61	< 23.19	< 24.15	24.31	24.73	23.95	< 21.93	< 23.17	23.45	< 22.24	< 21.40	< 21.04
33	26.84 ±0.00	.....	24.81 ±0.14	23.71 ±0.11	23.17 ±0.12	23.39 ±0.06	22.92 ±0.12	22.74 ±0.07	22.59 ±0.05	.....	22.54 ±0.16	22.52 ±0.10	< 22.26	< 21.43	< 21.00
34	27.03 ±0.15	26.33 ±0.46	< 24.63	< 23.45	< 23.13	23.75 ±0.13	23.45 ±0.12	23.49 ±0.13	23.27 ±0.16	< 21.82	23.23 ±0.19	22.99 ±0.22	23.11 ±0.08	< 21.13	< 20.76
35	27.62 ±0.00	.....	< 24.92	< 23.62	< 23.19	23.52 ±0.07	23.06 ±0.11	23.21 ±0.07	22.88 ±0.08	< 21.93	22.85 ±0.13	22.59 ±0.13	22.43 ±0.15	< 21.40	< 21.04
36	< 26.39	26.46 ±0.55	25.01 ±0.17	23.75 ±0.15	23.35 ±0.15	23.06 ±0.09	22.75 ±0.06	22.83 ±0.08	22.43 ±0.08	22.19 ±0.36	22.41 ±0.12	22.20 ±0.14	22.04 ±0.15	< 21.33	< 20.99
37	26.39 ±0.13	26.19 ±0.31	24.33 ±0.12	22.95 ±0.07	22.38 ±0.07	22.17 ±0.06	21.81 ±0.03	21.90 ±0.04	21.50 ±0.05	21.80 ±0.22	21.40 ±0.07	21.12 ±0.07	20.97 ±0.08	21.28 ±0.26	21.35 ±0.54
38	< 26.33	< 26.12	< 24.63	< 23.45	23.97	24.11	23.76	23.77	23.55	< 21.82	23.30	23.33	22.88	< 21.13	.....
39	.....	.....	< 24.92	< 23.62	< 23.19	±0.08 24.11	±0.14 23.65	±0.16 24.32	±0.31 23.73	< 21.92	±0.21 < 23.15	±0.37 23.29	±0.05 < 22.24	< 21.40	< 21.04
40	.....	.....	24.05 ±0.07	22.72 ±0.05	22.10 ±0.05	21.90 ±0.03	21.58 ±0.06	21.54 ±0.02	21.22 ±0.03	20.91 ±0.09	21.00 ±0.04	20.83 ±0.04	20.60 ±0.05	21.04 ±0.18	20.81 ±0.16
41	.....	.....	< 24.94	< 23.61	< 23.15	< 24.15	24.97	24.86	23.98	< 21.92	< 23.16	23.84	< 22.06	< 21.33	< 21.56
42	27.23	.....	< 25.08	< 24.36	24.23	24.23	23.45	23.63	23.23	.....	23.44	22.74	22.68	< 21.43	< 21.00

Table C3: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
43	±0.00 < 26.16	< 25.92	< 24.79	< 23.63	±0.18 23.82	±0.11 23.57	±0.11 23.17	±0.11 23.20	±0.09 23.21	< 21.82	±0.20 22.77	±0.13 22.56	±0.14 22.24	< 21.13	.....
44	27.35 ±0.00	.....	< 24.70	.....	±0.34 23.50	±0.09 22.84	±0.11 22.48	±0.07 .....	±0.22 22.31	±0.13 22.78	±0.12 22.42	±0.22 21.88	±0.18 21.73	23.16	< 21.00
45	25.89 ±0.00	.....	24.07	22.88	±0.16 21.87	±0.04 22.21	±0.13 21.80	21.81	±0.04 21.57	±0.13 21.76	±0.10 20.71	±0.06 21.08	±0.08 20.87	±0.36 21.02	20.69
46	26.74 ±0.34	27.08 ±0.53	< 24.94	24.39	±0.10 23.72	±0.06 23.40	±0.06 23.04	±0.02 23.09	±0.07 22.88	±0.03 21.78	±0.03 22.41	±0.13 22.50	±0.04 22.01	±0.13 22.17	±0.26 22.26
47	< 26.37	26.36 ±0.50	24.60	23.29	±0.21 22.61	±0.11 22.58	±0.14 22.11	±0.12 22.13	±0.13 21.84	±0.30 21.54	±0.11 21.62	±0.16 21.38	±0.29 21.09	±0.49 21.71	±0.27 21.77
48	27.43 ±0.00	.....	24.88	23.86	±0.12 23.11	±0.12 23.47	±0.07 23.23	±0.10 23.30	±0.08 22.92	< 21.92	±0.07 21.76	±0.14 22.71	±0.17 22.77	< 21.42	< 21.06
49	.....	.....	23.76	22.34	±0.14 21.88	±0.16 21.49	±0.07 21.12	±0.09 21.16	±0.19 20.91	±0.26 20.77	±0.08 20.62	±0.22 20.36	±0.14 20.07	±0.35 20.27	±0.58 20.04
50	< 26.31	< 26.49	< 24.67	< 23.50	±0.05 23.76	±0.02 23.26	±0.03 23.36	±0.03 23.36	±0.02 22.68	±0.07 < 21.92	±0.03 23.01	±0.03 22.42	±0.03 22.81	±0.10 < 21.35	±0.25 < 21.83
51	.....	.....	< 24.94	< 23.61	±0.05 23.09	±0.05 ±0.15	±0.02 ±0.18	±0.03 ±0.12	±0.03 ±0.12	±0.07 ±0.21	±0.03 ±0.15	±0.03 ±0.15	±0.03 ±0.39	< 21.32	< 20.83
52	< 26.31	26.59 ±0.56	< 24.83	24.02	< 23.15	< 24.08	24.73	25.14	24.08	< 21.92	< 23.14	23.64	< 22.15	< 21.32	< 20.84
53	.....	.....	< 24.92	< 23.62	< 23.25	24.29	23.73	24.13	23.73	< 21.92	23.86	23.66	< 22.15	< 21.32	< 20.99
54	< 26.37	< 26.21	< 24.94	< 23.61	< 23.15	24.50	24.10	24.13	22.48	20.62	22.73	22.23	< 21.84	< 21.14	< 21.48
55	< 26.37	< 26.75	< 24.94	< 23.61	< 23.15	24.62	24.14	23.89	23.16	22.28	23.18	22.97	< 21.84	< 21.14	< 21.48
56	< 26.32	< 26.75	< 24.94	< 23.61	< 23.15	24.38	24.25	24.00	23.51	< 21.55	24.25	23.23	< 21.84	< 21.14	< 20.83
57	< 26.31	< 26.49	< 24.83	< 23.50	23.86	23.50	23.18	23.13	22.81	22.90	22.36	22.25	21.95	< 21.35	23.43
58	.....	27.45 ±0.49	< 24.67	< 23.50	< 23.05	±0.04 23.00	±0.09 23.08	±0.15 22.91	±0.18 21.61	±0.00 < 21.55	±0.10 22.50	±0.14 21.34	±0.18 < 21.84	< 21.14	< 21.48
59	< 26.31	< 26.49	< 24.67	< 23.50	< 23.05	24.46	24.07	24.05	23.52	< 21.92	24.10	23.13	< 22.12	< 21.35	< 21.54
60	< 26.37	27.04 ±0.00	< 24.87	< 23.60	< 23.19	23.81	23.59	23.57	23.30	< 21.93	23.36	23.08	22.77	< 21.34	.....
61	< 26.37	< 26.91	< 24.87	< 23.60	< 23.19	24.68	24.28	24.22	23.90	.....	24.03	23.48	< 22.25	< 21.34	.....
62	.....	.....	24.65	23.34	22.82	±0.17 22.61	±0.14 21.24	±0.12 22.34	±0.12 21.95	±0.12 22.23	±0.00 21.85	±0.22 21.58	21.47	21.36	< 20.99
63	.....	.....	< 24.92	< 23.61	< 23.25	±0.08 24.64	±0.09 23.20	±0.09 25.27	±0.05 23.93	±0.05 < 21.93	±0.07 24.02	±0.07 23.72	±0.09 < 22.26	±0.14 < 21.42	< 21.06

Table C3: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
	[mag AB]														
64	< 26.37	< 26.93	< 24.60	23.68 ±0.08	22.90 ±0.10	22.85 ±0.03	±0.15 22.41 ±0.03	±0.22 22.43 ±0.03	±0.12 22.10 ±0.03	.....	±0.00 21.90 ±0.05	±0.23 21.57 ±0.05	21.37 ±0.07	21.54 ±0.22	.....
65	< 26.32	< 26.75	< 24.86	< 23.60	< 23.15	23.76 ±0.31	23.54 ±0.15	23.41 ±0.10	23.07 ±0.27	< 21.55	23.00 ±0.28	22.30 ±0.28	22.55 ±0.24	< 21.14	< 20.83
66	.....	.....	25.65 ±0.21	< 24.35	< 23.48	< 24.18	22.16 ±0.10	24.74 ±0.29	24.42 ±0.18	.....	< 23.54	23.92 ±0.24	< 22.26	< 21.42	< 21.06
67	< 26.32	< 26.75	< 24.92	< 23.61	< 23.17	24.45 ±0.39	24.16 ±0.28	24.43 ±0.21	23.53 ±0.28	< 21.91	23.81 ±0.23	23.22 ±0.24	< 22.13	< 21.14	< 21.52
68	26.28 ±0.17	26.14 ±0.35	24.50 ±0.09	22.97 ±0.08	22.57 ±0.09	22.17 ±0.04	21.81 ±0.04	21.80 ±0.03	21.50 ±0.03	21.56 ±0.13	21.21 ±0.09	20.96 ±0.05	20.68 ±0.05	20.98 ±0.13	21.06 ±0.32
69	.....	.....	24.04 ±0.08	22.89 ±0.06	22.24 ±0.07	22.46 ±0.03	21.81 ±0.07	21.98 ±0.04	21.89 ±0.03	.....	22.00 ±0.06	21.54 ±0.06	21.38 ±0.06	21.51 ±0.27	< 21.05
70	< 26.32	26.38 ±0.52	< 24.86	23.92 ±0.16	23.53 ±0.18	23.18 ±0.07	22.92 ±0.12	23.01 ±0.08	22.58 ±0.08	< 21.91	22.57 ±0.14	22.18 ±0.13	22.24 ±0.16	< 21.30	< 21.52
71	< 26.37	27.34 ±0.50	< 24.87	< 23.59	< 23.19	23.93 ±0.09	23.70 ±0.11	23.79 ±0.11	23.45 ±0.09	< 21.93	23.42 ±0.18	23.23 ±0.14	< 22.28	< 21.38	< 20.97
72	.....	.....	< 24.92	24.25 ±0.17	23.68 ±0.21	23.29 ±0.06	.....	22.96 ±0.05	22.59 ±0.07	22.77 ±0.47	22.52 ±0.11	22.05 ±0.09	21.99 ±0.12	< 21.42	< 21.00
73	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	24.71 ±0.38	24.46 ±0.19	24.36 ±0.15	23.87 ±0.13	< 21.94	24.17 ±0.40	23.45 ±0.22	< 22.23	< 21.41	< 21.56
74	< 26.37	< 26.85	25.00 ±0.15	22.99 ±0.08	22.04 ±0.06	21.66 ±0.03	20.94 ±0.02	20.90 ±0.01	20.63 ±0.02	20.01 ±0.04	19.75 ±0.02	19.27 ±0.02	18.83 ±0.01	18.76 ±0.03	19.26 ±0.21
75	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	24.89 ±0.00	24.43 ±0.18	24.30 ±0.15	23.89 ±0.13	< 21.92	< 23.13	23.57 ±0.22	< 22.23	< 21.41	< 21.55
76	< 26.37	27.09 ±0.30	< 24.90	< 23.61	< 23.20	24.22 ±0.11	23.92 ±0.13	24.05 ±0.12	23.59 ±0.12	< 21.94	23.56 ±0.18	23.36 ±0.23	< 22.23	< 21.41	< 21.56
77	< 26.37	26.80 ±0.00	< 24.91	< 23.61	< 23.14	23.52 ±0.04	23.33 ±0.07	23.35 ±0.06	22.81 ±0.05	< 21.94	23.07 ±0.13	22.51 ±0.10	< 22.28	< 21.38	< 20.97
78	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	24.32 ±0.11	23.82 ±0.11	23.87 ±0.10	23.19 ±0.09	< 21.92	23.49 ±0.20	22.73 ±0.16	22.78 ±0.17	< 21.41	< 20.97
79	.....	.....	< 24.93	< 23.61	< 23.21	23.64 ±0.09	.....	23.30 ±0.08	23.01 ±0.11	< 21.93	22.99 ±0.16	22.65 ±0.14	22.89 ±0.00	< 21.42	< 21.00
80	.....	.....	< 24.93	< 23.62	< 23.21	< 24.16	< 24.13	< 24.28	24.17 ±0.19	< 21.93	< 23.13	23.82 ±0.26	< 22.24	< 21.42	< 21.00
81	26.01 ±0.08	25.46 ±0.19	23.80 ±0.05	22.62 ±0.05	22.07 ±0.04	21.92 ±0.02	21.69 ±0.03	21.62 ±0.02	21.36 ±0.02	21.37 ±0.08	21.15 ±0.04	20.95 ±0.05	20.77 ±0.07	21.08 ±0.17	21.52 ±0.38
82	< 26.37	.....	< 24.86	< 23.60	< 23.15	< 24.06	.....	24.18 ±0.18	22.97 ±0.11	< 21.91	22.77 ±0.15	21.99 ±0.11	21.93 ±0.13	< 21.30	20.63 ±0.22
83	26.71 ±0.30	< 26.85	< 24.70	23.64 ±0.08	23.28 ±0.16	22.80 ±0.05	22.57 ±0.07	22.49 ±0.05	22.05 ±0.05	< 21.92	21.94 ±0.07	21.59 ±0.08	21.48 ±0.10	21.38 ±0.12	22.18 ±0.51
84	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	24.24	23.93	24.14	23.73	< 21.92	23.53	23.36	< 22.23	< 21.41	< 21.56



Table C3: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
								[mag AB]							
85	< 26.32	< 26.75	< 24.93	< 23.62	< 23.21	< 24.16	< 24.13	< 24.28	22.67 ±0.07	< 21.93	< 23.16	21.50 ±0.06	< 22.24	< 21.42	20.29 ±0.20
86	< 26.37	< 26.90	< 24.91	< 23.61	< 23.14	24.03 ±0.10	23.65 ±0.10	23.58 ±0.07	23.09 ±0.06	< 21.94	22.84 ±0.12	22.52 ±0.10	22.44 ±0.12	< 21.38	< 20.97
87	< 26.37	< 26.85	< 24.90	< 23.61	< 23.20	23.83 ±0.09	23.74 ±0.11	23.59 ±0.08	22.95 ±0.08	< 21.92	23.01 ±0.15	22.63 ±0.15	< 22.23	< 21.41	< 20.97
88	.....	.....	< 24.92	< 23.62	< 23.26	24.63 ±0.15	24.24 ±0.28	24.26 ±0.15	23.82 ±0.12	< 21.93	23.68 ±0.24	23.46 ±0.21	< 22.27	< 21.46	< 21.05
89	.....	.....	< 24.93	< 23.62	< 23.21	< 24.16	< 24.39	< 24.28	24.25 ±0.20	< 21.94	< 23.16	23.81 ±0.26	< 22.24	< 21.42	< 21.00
90	.....	.....	< 24.93	< 23.62	23.90 ±0.00	23.79 ±0.11	23.32 ±0.19	23.37 ±0.07	22.97 ±0.10	< 21.94	23.00 ±0.15	22.55 ±0.12	22.36 ±0.16	< 21.42	< 20.95
91	< 26.37	< 26.85	< 24.93	< 23.61	< 23.25	24.30 ±0.11	21.81 ±0.04	23.84 ±0.10	23.51 ±0.12	< 21.92	23.39 ±0.21	22.93 ±0.18	22.80 ±0.25	< 21.41	< 20.97
92	.....	.....	< 24.93	< 23.61	< 23.25	24.17 ±0.14	23.20 ±0.11	23.93 ±0.09	23.44 ±0.10	< 21.92	23.46 ±0.21	22.96 ±0.18	22.66 ±0.20	< 21.41	< 20.97
93	.....	.....	< 24.86	< 23.61	< 23.25	23.93 ±0.07	23.51 ±0.34	23.60 ±0.08	23.16 ±0.07	< 21.92	23.43 ±0.21	22.80 ±0.13	23.07 ±0.01	< 21.40	< 21.05
94	.....	.....	.....	.....	.....	24.85 ±0.05	24.39 ±0.18	..... ±0.12	24.02 ±0.12	.....	.....	23.68 ±0.20	< 22.25	< 21.39	.....
95	< 26.37	< 26.90	25.00 ±0.10	23.85 ±0.08	22.51 ±0.08	22.68 ±0.03	21.75 ±0.04	22.28 ±0.03	21.93 ±0.03	22.13 ±0.15	21.72 ±0.05	21.42 ±0.04	21.15 ±0.06	21.42 ±0.23	< 21.01
96	.....	.....	.....	.....	.....	23.40 ±0.05	22.01 ±0.07	23.22 ±0.06	22.62 ±0.05	23.07 ±0.00	22.85 ±0.13	22.22 ±0.06	22.13 ±0.10	< 21.40	< 21.03
97	< 26.37	.....	< 24.87	24.40 ±0.08	< 23.21	23.79 ±0.07	23.12 ±0.12	23.56 ±0.07	23.11 ±0.07	< 21.94	23.10 ±0.15	22.81 ±0.12	< 22.26	< 21.41	< 21.01
98	.....	.....	24.55 ±0.10	22.71 ±0.05	21.89 ±0.04	21.73 ±0.01	21.23 ±0.03	21.32 ±0.01	21.04 ±0.01	21.01 ±0.05	20.71 ±0.03	20.45 ±0.02	20.19 ±0.03	20.07 ±0.06	20.40 ±0.21
99	.....	.....	.....	25.26 ±0.07	22.45 ±0.07	23.03 ±0.04	22.00 ±0.06	24.10 ±0.14	22.38 ±0.04	22.70 ±0.00	22.34 ±0.10	22.00 ±0.07	21.87 ±0.08	23.26 ±0.39	< 21.03
100	.....	.....	24.63 ±0.09	23.69 ±0.14	23.17 ±0.12	22.88 ±0.04	22.60 ±0.07	22.70 ±0.04	22.36 ±0.04	22.70 ±0.00	22.24 ±0.07	22.09 ±0.07	21.97 ±0.08	22.81 ±0.30	< 21.04
101	.....	.....	.....	.....	.....	24.44 ±0.12	23.30 ±0.09	..... ±0.08	23.53 ±0.08	.....	.....	23.01 ±0.14	< 22.25	23.80 ±0.40	.....
102	< 26.37	.....	< 24.87	< 23.61	.....	24.23 ±0.08	23.33 ±0.09	24.05 ±0.11	23.52 ±0.08	.....	.....	23.29 ±0.16	< 22.25	< 21.39	.....
103	.....	.....	22.84 ±0.02	21.62 ±0.03	21.27 ±0.02	20.99 ±0.01	20.61 ±0.01	20.70 ±0.01	20.43 ±0.01	20.54 ±0.04	20.26 ±0.01	20.09 ±0.02	19.89 ±0.02	19.99 ±0.07	.....
104	.....	.....	< 25.09	< 24.33	< 23.52	25.01 ±0.00	24.20 ±0.18	24.34 ±0.25	24.13 ±0.12	.....	< 23.56	23.52 ±0.16	< 22.26	< 21.40	< 21.04
105	.....	.....	< 25.09	< 24.33	< 23.52	24.70	23.47	24.22	23.88	.....	< 23.57	23.53	< 22.26	< 21.36	< 21.03

Table C3: *Continued*

#	FUV	NUV	F336W	F410M	F467M	F475W	F555W	F547M	F606W	F658N	F702W	F814W	F850LP	<i>J</i>	<i>K<sub>s</sub></i>
[mag AB]															
106	.....	.....	23.59 ±0.06	22.34 ±0.03	21.77 ±0.04	21.80 ±0.02	21.32 ±0.03	21.49 ±0.03	21.26 ±0.02	.....	20.71 ±0.03	20.94 ±0.03	20.78 ±0.04	21.11 ±0.15	22.17 ±0.54
107	.....	.....	25.51 ±0.20	24.34 ±0.15	24.20 ±0.26	24.08 ±0.09	23.49 ±0.34	22.80 ±0.07	23.27 ±0.08	.....	.....	22.93 ±0.13	< 22.26	< 21.36	< 21.05
108	.....	.....	< 24.87	< 23.61	< 23.21	24.81 ±0.32	24.55 ±0.24	24.52 ±0.17	24.04 ±0.12	< 21.94	.....	23.65 ±0.20	< 22.25	< 21.39	.....
109	.....	.....	< 25.09	< 24.33	< 23.52	24.93 ±0.00	24.52 ±0.21	< 24.60	24.06 ±0.11	.....	23.93 ±0.31	23.62 ±0.18	< 22.26	< 21.40	< 21.04
110	.....	.....	.....	.....	23.46 ±0.19	24.38 ±0.13	23.98 ±0.20	.....	23.51 ±0.11	< 21.94	23.70 ±0.26	23.16 ±0.16	22.97 ±0.00	< 21.40	< 21.04
111	.....	.....	.....	.....	23.45 ±0.15	24.14 ±0.10	23.81 ±0.18	.....	23.46 ±0.08	< 21.94	23.29 ±0.17	23.17 ±0.14	< 22.26	< 21.41	< 21.04
112	.....	.....	< 25.11	< 24.33	< 23.56	< 24.12	24.53 ±0.24	23.31 ±0.11	24.25 ±0.16	.....	< 23.15	23.79 ±0.27	< 22.25	< 21.40	23.59 ±0.14
113	.....	.....	< 24.93	< 23.62	< 23.20	24.67 ±0.19	24.06 ±0.13	.....	23.81 ±0.14	.....	.....	23.36 ±0.19	< 22.26	< 21.39	< 21.05
114	.....	.....	.....	.....	.....	23.38 ±0.05	23.18 ±0.07	.....	22.75 ±0.06	.....	.....	22.55 ±0.10	22.62 ±0.18	< 21.40	< 21.02
115	27.79 ±0.00	.....	< 25.08	< 24.32	< 23.47	24.90 ±0.00	24.26 ±0.17	24.19 ±0.14	23.90 ±0.11	< 21.94	24.30 ±0.15	23.61 ±0.18	< 22.29	< 21.44	< 21.04